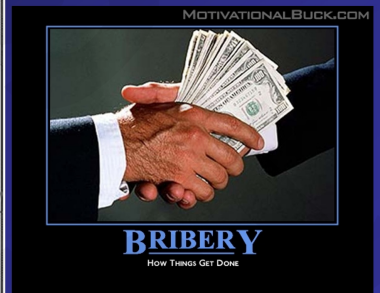


Spinal Cord Injury – Acute and Surgical Management (for Neurologists!)

Mr M J H McCarthy
Consultant Spinal Surgeon



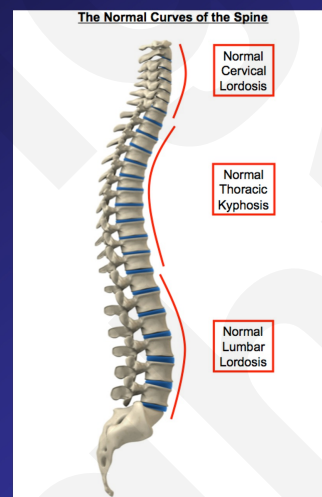
No Disclosures No Conflicts of Interest



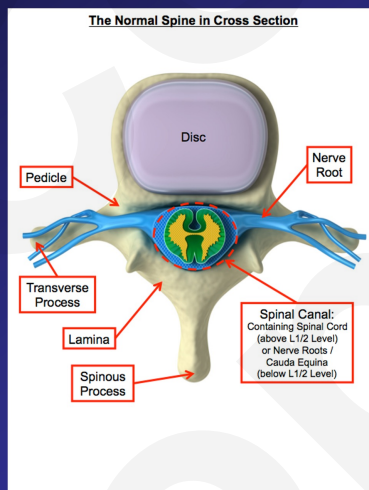
Aims / Objectives

- Anatomy and Biomechanics of the Spine
- Pathophysiology of Spinal Cord Injury
- Investigations
- Initial Management
- Examples
- Miscellaneous

The Normal Curves of the Spine

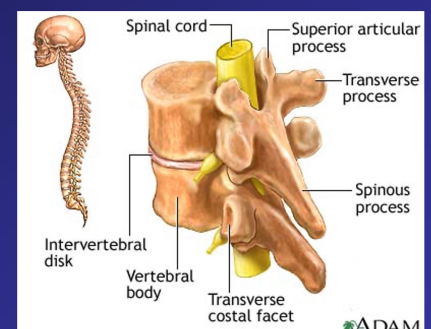


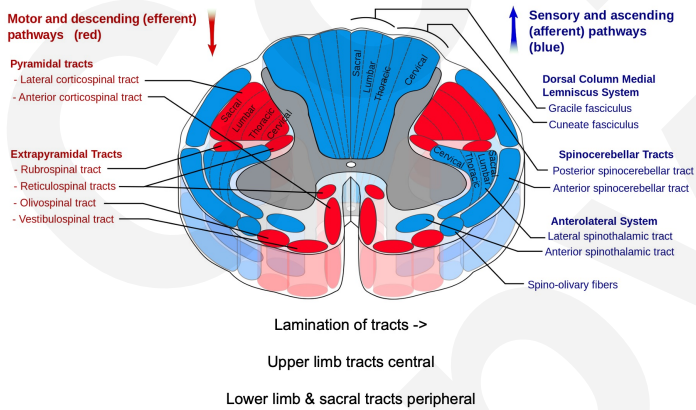
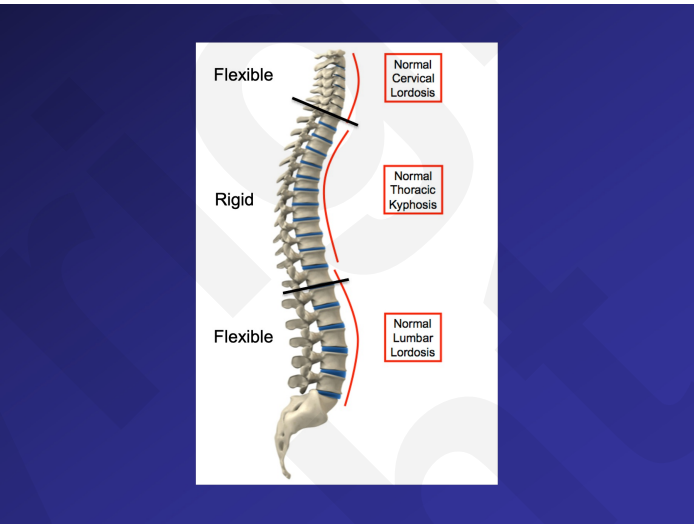
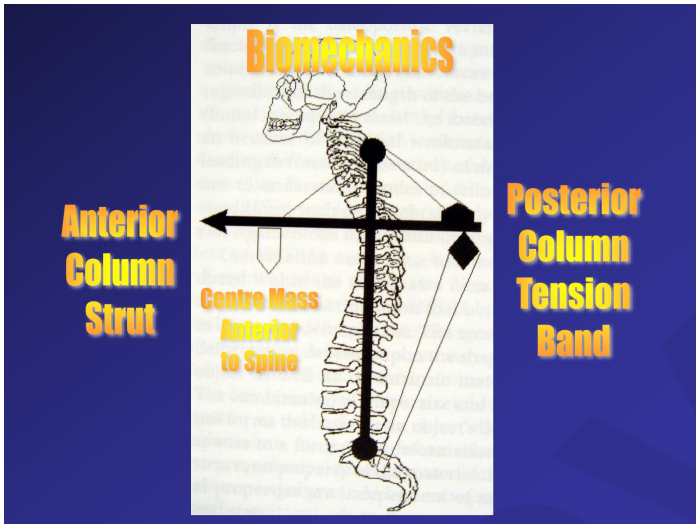
The Normal Spine in Cross Section



Function

- Movement
- Protects cord
- Support





Pathway	Direction	Origin	Cross-over	Destination	Function
Corticospinal	Descending	Motor cortex	90% as lateral CST; 10% as anterior CST	Alpha motor neurons	Skilled motor to extremities
Reticulospinal	Descending	Reticular formation	Variable levels	Alpha and gamma motor neurons	Cortical control of voluntary motor function
Rubrospinal	Descending	Red nucleus	Immediate	Alpha and gamma motor neurons	Facilitate flexors, inhibit extensors (for balance control)
Vestibulospinal	Descending	Vestibular nucleus	None	Alpha and gamma motor neurons	Facilitate extensors and inhibit flexors (for balance control)
Lateral spinothalamic	Ascending	Free nerve endings	Immediate	Posterior central gyrus	Pain, temperature
Anterior spinothalamic tract	Ascending	Free nerve endings	Variable levels	Posterior central gyrus	Light touch and pressure
Posterior column: fasciculus gracilis and cuneatus	Ascending	Meissner's corpuscles, Pacinian corpuscles, muscle spindle, tendon organs	None	Posterior central gyrus	Discriminative touch, vibration sense, proprioception

Tract	Column Location	Decussation location	Function
Ascending Tracts - Sensory			
Gracile fasciculus	posterior	medulla	below level T6: limb and trunk position sensations; deep touch; visceral pain; vibration
Cuneate fasciculus	posterior	medulla	level T6 and above: limb and trunk position sensations; deep touch; visceral pain; vibration
Spinothalamic	lateral and anterior	spinal cord	light touch, tickle, itch, temperature, pain, and pressure sensations
Spinoreticular	lateral and anterior	some fibers of the spinal cord	pain sensation from tissue injury
Posterior spinocerebellar	lateral	none	proprioception - feedback from muscles
Anterior spinocerebellar	lateral	spinal cord	proprioception - feedback from muscles
Descending Tracts - Motor			
Lateral corticospinal	lateral	medulla	fine limb control
Anterior corticospinal	anterior	spinal cord	fine limb control
Tectospinal	anterior	midbrain	head-turning reflex in response to visual and auditory stimuli
Lateral reticulospinal	lateral	none	posture and balance; awareness of pain regulation
Medial reticulospinal	anterior	none	posture and balance; awareness of pain regulation
Lateral vestibulospinal	anterior	none	posture and balance
Medial vestibulospinal	anterior	some fibers of the medulla	head position control

Name	Cell body	Location	Decussation	Ending	Function
Lateral corticospinal ¹	Cortex (premotor & sensory) (upper motor neuron)	Posterior limb of In. Capsule, middle 2/3 of crus cerebri, pyramid in medulla	Medulla Spinal cord	Anterior gray column cells (interneurons & lower motor neurons)	Fine skilled motor activity, modulation of sensory function
Anterior corticospinal ²	"	"	"	"	Gross & postural motor
Corticonuclear	"	Germ of Internal capsule, middle 2/3 of crus cerebri	Brain stem	Cranial nerve nuclei	Fine skilled motor activity modulation of sensory function
Vestibulospinal ³	Lateral vestibular nucleus	Anterior column	Non	Ventral gray column in lower spinal levels	Postural reflexes, control of extensor tone
Rubrospinal ³	Red nucleus	Lateral column	Upper midbrain (Ventral)	Ventral horn interneurons	Flexor tonicity
Tectospinal ³	Superior colliculus	Anterior column	Upper midbrain (dorsal)	Dorsal and ventral gray column	Head turning reflex
Reticulospinal ³	Brain stem reticular formation	Anterior column	Crossed & uncrossed	Ant gray column, interneuron	Modulation of sensory transmission (pain)
Medial longitudinal fasciculus	Medial vestibular nucleus	Anterior column	?	Cervical & midthoracic anterior column (extended to upper part of brain stem as well, and join together at this level)	Coordination of head & eye movements
Descending autonomic	Hypothalamus	Within reticulospinal tract ⁴	?	Preganglionic autonomic neurons	Modulation of autonomic functions

Updated in 2008
¹ Pyramidal pathway
² Extrapyramidal pathway
³ Posterior and lateral column according to Gray, 5 Anatomy 1995 (2005)

Tracts	Characteristics
Dorsal Columns/ Medial lemniscal	- Convey sensations of proprioception, vibration, tactile discrimination - Fasciculus cuneatus and gracilis - Nerve fibers ascend to medulla where they cross to form medial lemniscus, ascend to thalamus, then to cortex
Spinothalamic	- Lateral conveys pain and temperature - Medial conveys crude touch - Tracts ascend one or two ipsilateral spinal cord segments, then cross to the contralateral segment of the spinal cord, ascend to thalamus
Spinocerebellar	- Convey proprioception - Dorsal tracts ascend to ipsilateral cerebellum - Ventral tracts ascend to contralateral and ipsilateral cerebellum
Spinoreticular	Convey deep and chronic pain

SPINAL CORD TRACT	LOCATION (FUNICULUS)	ORIGIN	TERMINATION	FUNCTION
Direct (Pyramidal) Pathways				
Lateral corticospinal	Lateral	Pyramidal neurons of motor cortex of the cerebrum. Cross over in pyramids of medulla.	By synapse with ventral horn interneurons that influence motor neurons and occasionally with ventral horn motor neurons directly.	Transmits motor impulses from cerebrum to spinal cord motor neurons (which activate skeletal muscles on opposite side of body). A voluntary motor tract.
Ventral corticospinal	Ventral	Pyramidal neurons of motor cortex. Fibers cross over at the spinal cord level.	Ventral horn (as above).	Same as lateral corticospinal tract.
Indirect Pathways				
Tectospinal	Ventral	Superior colliculus of midbrain of brain stem (fibers cross to opposite side of cord).	Ventral horn (as above).	Turns neck so eyes can follow a moving object.
Vestibulospinal	Ventral	Vestibular nuclei in medulla of brain stem (fibers descend without crossing).	Ventral horn (as above).	Transmits motor impulses that maintain muscle tone and activate ipsilateral limb and trunk extensor muscles and muscles that move head. Helps maintain balance during standing and moving.
Rubrospinal	Lateral	Red nucleus of midbrain of brain stem (fibers cross to opposite side just inferior to the red nucleus).	Ventral horn (as above).	In experimental animals, transmits motor impulses concerned with muscle tone of distal limb muscles (mostly flexors) on opposite side of body. In humans, functions are largely assumed by corticospinal tracts.
Reticulospinal (ventral, medial, and lateral)	Ventral and lateral	Reticular formation of brain stem (medial nuclear group of pons and medulla). Both crossed and uncrossed fibers.	Ventral horn (as above).	Transmits impulses concerned with muscle tone and many visceral motor functions. May control most unskilled movements.

[illegible]

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, full range of motion (ROM) with gravity eliminated
3 = active movement, full ROM against gravity
4 = active movement, full ROM against gravity and moderate resistance in a muscle specific position
5 = (normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person
5+ = (normal) active movement, full ROM against gravity and sufficient resistance to be considered normal if identified inhibiting factors (i.e. pain, disuse) were not present
NT = not testable (i.e. due to immobilization, severe pain such that the patient cannot or cannot tolerate, amputation of limb or contracture of > 50% of the normal range of motion)

A = Complete. No sensory or motor function is preserved in the sacral segments S4-S5.

B = Sensory incomplete. Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5 (light touch or pin prick at S4-S5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body.

C = Motor incomplete. Motor function is preserved below the neurological level, and more than half of key muscle functions below the neurological level of injury (NLI) have a muscle grade less than 3 (Grades 0-2).

The following order is recommended for determining the classification of individuals with SCI:

1. **Determine sensory levels for right and left sides.**
The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation.

2. Determine motor levels for right and left sides.
Defined by the lowest key muscle function that has a grade of at least 3 (on supine testing); providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5).
Note: in regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level; if testable motor function above that level is also normal.

0 = Absent
1 = Altered, either decreased/impaired sensation or hypersensitivity
2 = Normal

Non Key Muscle Functions (optional)

Shoulder: Flexion, extension, abduction, adduction, internal and external rotation
Elbow: Supination
Elbow: Pronation

Finger: Flexion at proximal joint, extension.
Thumb: Flexion, extension and abduction in plane of thumb

Finger: Flexion at MCP joint
Thumb: Opposition, adduction and abduction perpendicular to palm

Hip: External rotation

Hip: Extension, abduction, internal rotation
Knee: Flexion
Ankle: Inversion and eversion
Toe: MP and P extension

Hallux and Toe: DIP and PIP flexion and abduction
Hallux: Adduction

D = Motor incomplete. Motor function is preserved below the neurological level¹, and at least half (half or more) of key muscle functions below the NLI have a muscle grade ≥ 3 .

E = Normal. If sensation and motor function as tested with the SNCSQ are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an

* For an individual to receive a grade of C or D, i.e. motor incomplete status, they must have either (1) voluntary anal sphincter contraction or

...sacra sensory (using $\geq 50\%$ spiking or motor function more than three levels below the motor level for that side of the body). The International Standards at this time allows even non-key muscle function more than 3 levels below the motor level to be used in determining motor incomplete status (AIS B versus C).

NOTE: When assessing the extent of motor sparing below the level or distinguishing between AIS B and C, the **motor level** on each side is used; whereas to differentiate between AIS C and D (based on proportion of key muscle functions with sensory grade 2 or greater), the

FRANKEI



INTERNATIONAL STANDARDS FOR NEUROLOGICAL
CLASSIFICATION OF SPINAL CORD INJURY



ISCOS
INTERNATIONAL SCHOOL OF CONSTRUCTION

3. Determine the neurological level of injury (NLI)
This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally respectively.

4. Determine whether the injury is Complete or Incomplete.

If voluntary anal contraction = **No** AND all S4-5 sensory scores = **0**
AND deep anal pressure = **No**, then injury is **Complete**.
Otherwise, injury is **Incomplete**.

5. Determine ASIA Impairment Scale (AIS) Grade:
Is injury Complete? If YES, AIS=A and can record ZPP (lowest dermatome or myotome)

Is Injury Motor Complete? If YES, AIS=B

more than three levels below the motor level on a given side, if the patient has sensory incomplete classification)

Are at least half (half or more) of the key muscles below the neurological level of injury graded 3 or better?

NO ↓ YES ↓

AIS=C **AIS=D**

If sensation and motor function is normal in all segments, AIS=E
Note: AIS E is used in follow-up testing when an individual with a documented

SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact; the ASA Impairment Scale does not apply.

Suspecting a Spinal Injury





Suspecting a Spinal Injury

- Mechanism of Injury
- Unconscious
- Neurological Deficit
- Spinal Pain / Tenderness

Goals of Spine Trauma Care

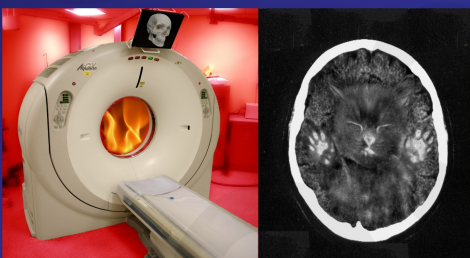
- Protection
- Detection
- Optimize conditions for neuro recovery
- Maintain / restore spinal alignment
- Minimize loss of spinal mobility
- Obtain healed and stable spinal column
- Rehabilitation
- #s = Manage the ass soft tissue injury

Management of Spinal Injury

- ABCDE / ATLS Approach
- Protection - **THINK SPINAL CORD INJURY**
 - Maintain airway with spine control
 - Always aim to have a team of 6 for transfers (min 4 for log rolls)
- **Detection**
 - Level of injury
 - Complete or Incomplete cord injury
 - Spinal or Neurogenic shock
- **Management**
 - Conservative or Surgical treatment

AB and CT

- ATLS Cervical XR
 - Now part of secondary survey
 - It doesn't change initial management



Immobilise The Entire Spine



Stiff Neck Collar

The Spinal Board

- Transport device
- Remove ASAP
- Regular log rolls
- Pressure sores
- Same goes for some collars...

Assessment

- **History**
 - Pain
 - Mechanism
 - Immediate post injury neurology
 - Associated injury
- **Examination**
 - Spine
 - Tenderness
 - Gap
 - Step
 - Marked spasm
 - Spinal cord
- **Imaging**

Examination

- Spinal Cord
- Partial / Complete SCI
 - Sensory level
 - Sensory modality
 - Motor level
 - Sphincter tone
 - Bulbocavernosus reflex

Examination

SCI in the Unconscious Patient

- Flaccid areflexia
- Diaphragmatic breathing
- Pain response above clavicle
- Bradycardia / Hypotension
- Priapism



Spinal “Shock”

- Refers to the flacid paralysis, areflexia and lack of sensation secondary to physiologic spinal cord “shut down” in response to injury
- Usually resolves within 24 hours when reflex arcs caudal to injury return
- Lowest that can be tested clinically
 - bulbocavernosus reflex
- **Importance of spinal shock**
 - determining whether a patient has a complete or incomplete spinal cord injury

Neurogenic Shock

- State of inadequate tissue perfusion and oxygenation due to:
- Reduced sympathetic outflow (T1-L2) with resultant unopposed vagal tone
- Hypotension due to loss of blood vessel tone with resultant venous pooling
- Bradycardia due to reduced cardiac stimulation
 - distinguishes neurogenic shock from other types of shock (e.g. hypovolaemic, cardiac, anaphylactic)

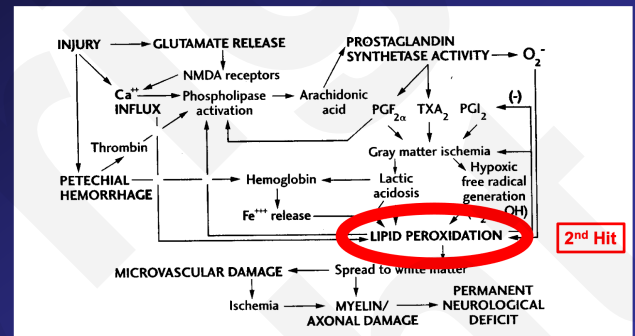
Pathophysiology SCI

- Primary injury:
 - Initial insult to cord
 - Local deformation
 - Energy transformation



Pathophysiology SCI

- Secondary injury
 - Biochemical cascade
 - Cellular processes
 - Therapy aims to reduce the secondary injury



Hypoxia Hypoperfusion

Spinal Cord Injury

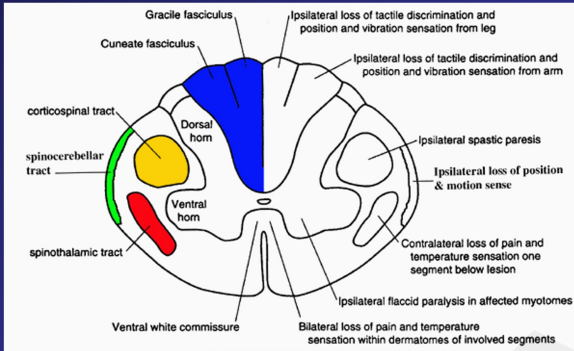
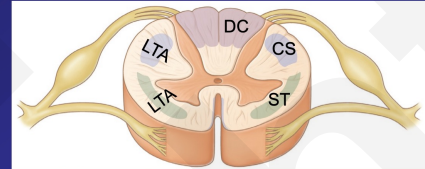
- Primary (at the time of injury)
- Secondary (occurring after the injury)
- Complete spinal cord injury
 - no sensation or voluntary motor function below the level of the injury
- It can only be confirmed after the resolution of spinal shock when reflex activity has returned
- The level of the injury is defined as the first with useful partial neurological function >3/5
- The overall prognosis for recovery of neurological function in complete lesions is poor

Spinal Cord Injury

- Incomplete spinal cord injury means that there is some function caudal to the injury
- In general, the greater the function the faster the recovery and better the prognosis
- Sacral sparing after spinal cord injury
 - the presence of sacral sensation, voluntary rectal tone and great toe movement
 - indicates intact long tract neurones and the potential for recovery
- Prognostic for predicting recovery except in lesions involving the conus medullaris or cauda equina

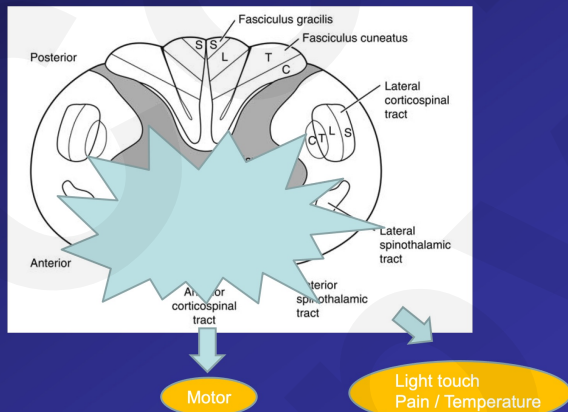
Cord Syndromes

- Anterior
- Posterior
- Central
- Brown-Sequard



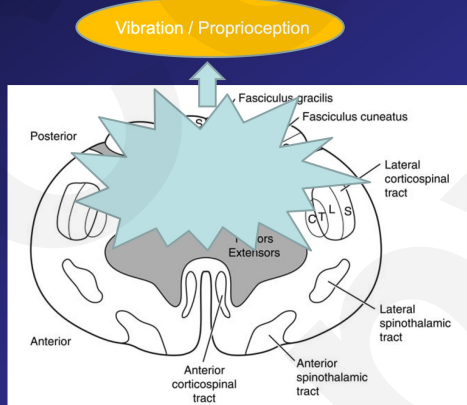
Anterior Cord Syndrome

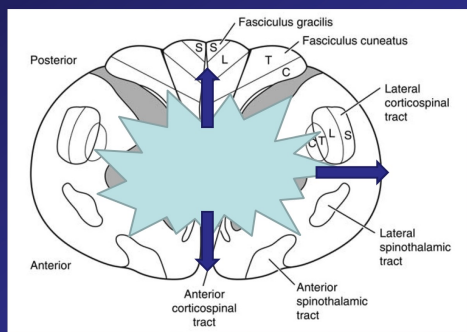
- Mostly vascular in origin
- Bilateral spastic paralysis
- Loss of pain, temperature, light touch & pressure with some degree of sacral sparing
- Preservation of proprioception, vibration 2 point discrimination



Posterior Cord Syndrome

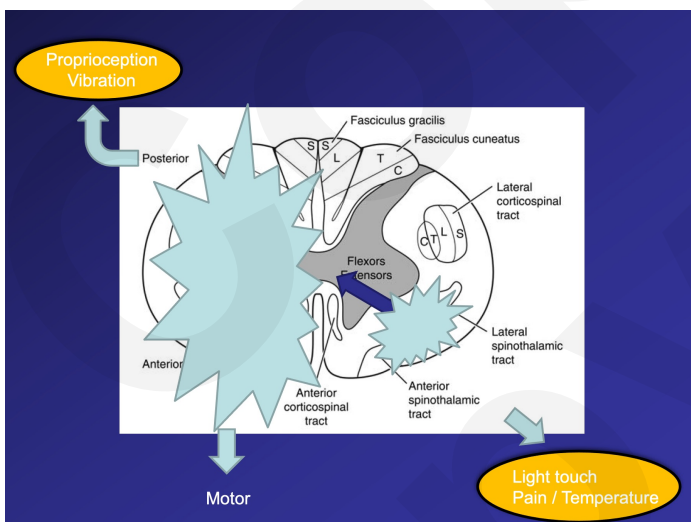
- Rare
- Loss of proprioception, vibration and 2 point discrimination
- Motor preservation





Central Cord Syndrome

- Cervical spondylosis
- Bilateral spastic paralysis
- Sacral sparing
- Upper limbs > Lower limbs – Cape distribution
- Recovery pattern LL > bladder > UL > sensory

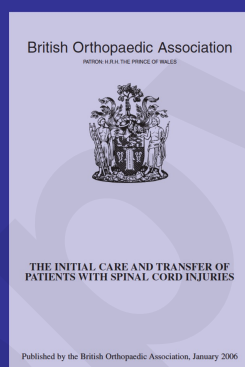


Brown Sequard

- Usually penetrating injury
- Ipsilateral paralysis
- Dissociate anaesthesia - loss of ipsilateral touch & contralateral pain / temp
- Best prognosis for ambulation

Spinal Cord Injury

- Of 569 patients admitted to Spinal Cord Injuries Centre in UK:
 - 9% missed at presentation
 - 5% experienced further avoidable deterioration
 - 1/3 of those missed had significant head injury
- Multiple Fractures in 5%
- Use of Steroids
 - NOT recommended



Spinal Injury Screening

- Clinically
 - Cooperative patient
 - Alert and orientated
 - Able to concentrate on spine
 - Normal neurological exam
 - No spinal pain or tenderness
 - No pain or tenderness with voluntary movement
- Probably not possible in the field

Spinal Injury Screening

- Altered consciousness or symptoms
 - Radiological imaging required
 - Presume the spine is unstable
 - Protect

Spinal Injury Screening

- Lateral Cervical X-Ray
 - Detects 85% cervical fractures
- Image the entire spine
 - 10% with one fracture have another non contiguous injury

Lateral C Spine Assessment

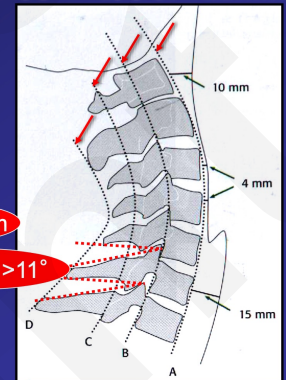
- Name / Age
- Date
- Type of Radiograph
- A : ADEQUACY / ALIGNMENT
- B : BONE
- C : CARTILAGE (Facets / Discs)
- D : DENS
- E : EXTRAAXIAL SOFT TISSUE



DISC SPACE WIDENING

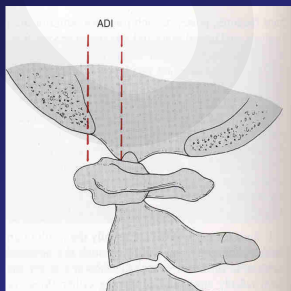


C2 = $<1/3$ or $<5\text{mm}$
C5 = $<2/3$ or $<22\text{mm}$



Step $>3.5\text{mm}$

Difference $>11^\circ$

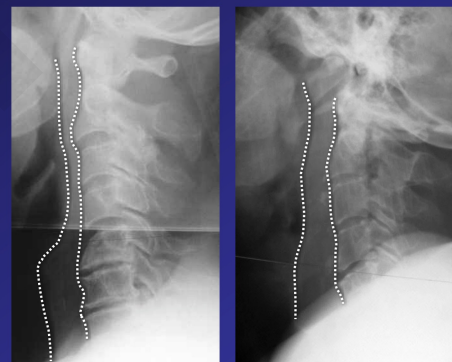


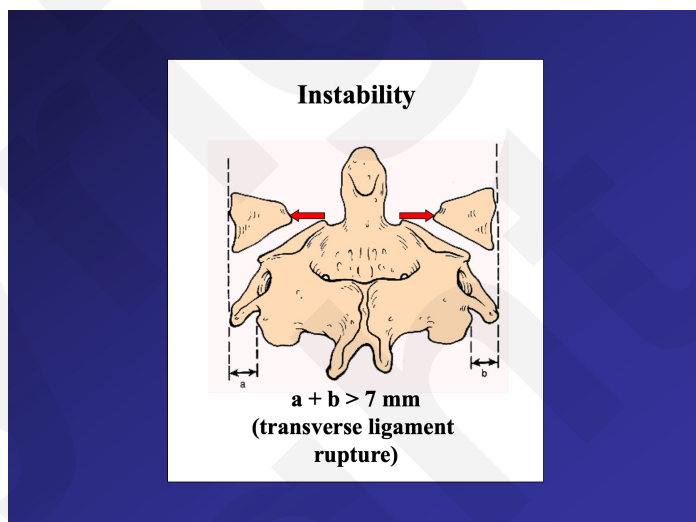
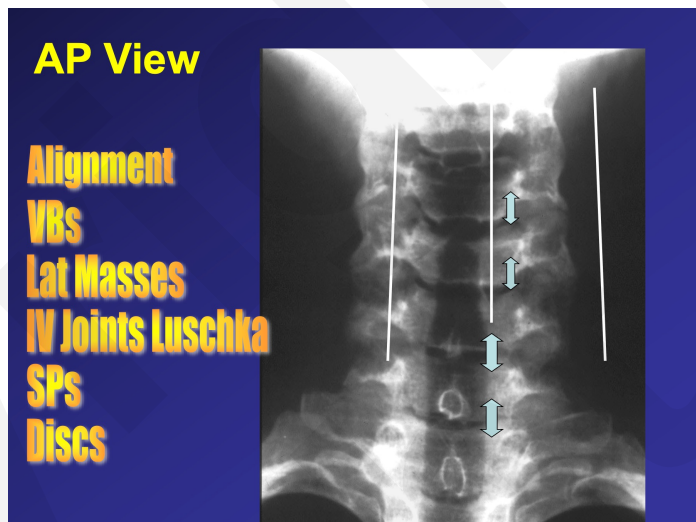
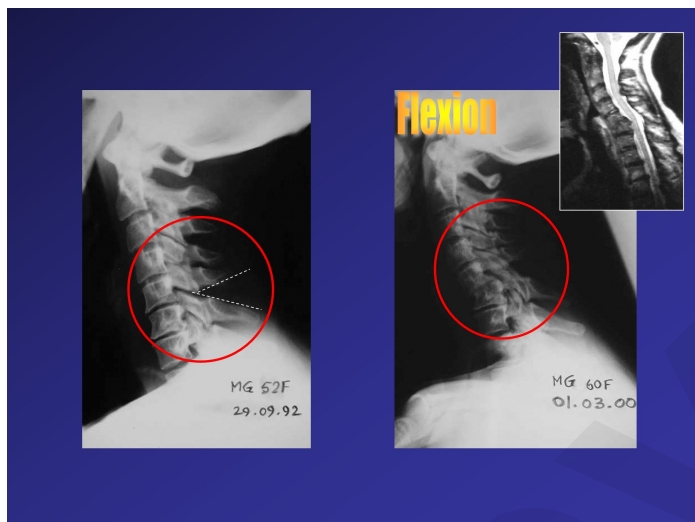
Atlas Dens Interval (ADI)

ADI = 3mm ($<5\text{mm}$)

$>5\text{mm}$ = Transverse + Accessory ligament rupture

Steels Rule of Thirds





CT Indications

- Plain Radiographs have failed to visualise all the cervical spine
 - Cervico-thoracic junction
 - Intubated patient (no odontoid peg view) – continue brain CT down to C3
- Plain Radiographs show injury
 - Confirm and further categorise extent of injury

MRI in Spinal Trauma

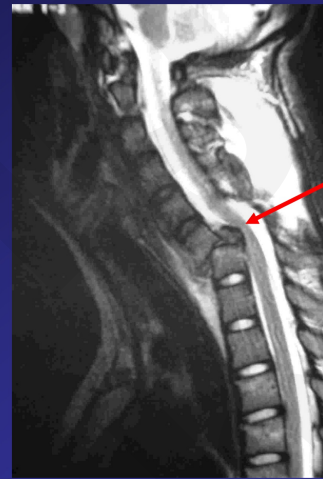
- Overview for exclusion of injury in difficult cases (ankylosing spondylitis)
- Ligamentous injury
- Unexplained neurology
- Prognosis in neurological injury
- Is surgical fixation safe?
 - Extruded disc may be made worse by surgical manipulation

Radiology of Cervical Spine

dislocation with
normal neurology

MRI

reduction



DISC



The Spine Journal 14 (2014) 2546–2553

THE
SPINE
JOURNAL

Clinical Study

The role of magnetic resonance imaging in acute cervical spine fractures

Sina Pourtaheri, MD^{a,*}, Arash Emami, MD^a, Kumar Sinha, MD^a, Michael Faloony, MD^a,
Ki Hwang, MD^b, Eiman Shafa, MD^a, Laurens Holmes, Jr., MD, PhD^b

^aDepartment of Orthopedic Surgery, Seton Hall University–St Joseph's Regional Medical Center, 703 Main St. Paterson, NJ 07503, USA

^bDepartment of Orthopedic Surgery, Nemours/Alfred I. DuPont Children's Hospital, 1600 Rockland Rd, Wilmington, DE 19803, USA

- 99 pts **cervical spine fractures** - CT and MRI
- Risk factors further injury seen only on MRI:
 - Male over 60yrs, polytrauma, cervical spondylosis, neurological deficit, obtunded
 - Suggest consideration to MRI in these subgroups



- MRI - additional info – 48%
 - Change management 39% (?- 20% group)
 - 24% non op management changed to op
- The change management
 - 81% illustration spinal cord
 - 19% occult instability

Erect Radiographs to Assess Clinical Instability in Patients with Blunt Cervical Spine Trauma

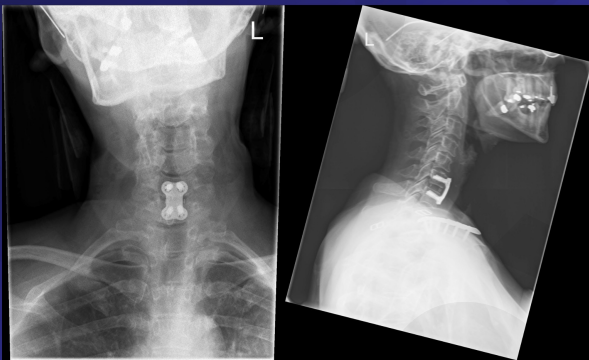
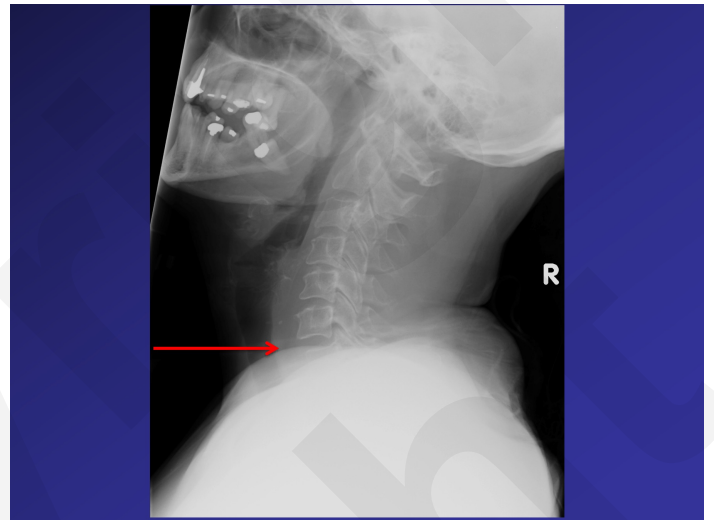
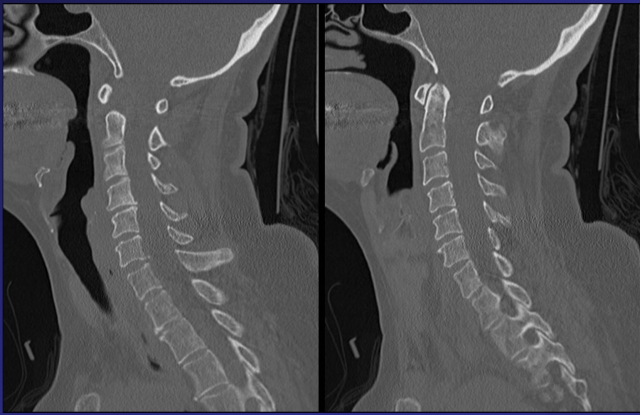
J Bone Joint Surg Am. 2012;94:e174(1-4)

Simon Humphry, MRCS, Andrew Clarke, FRCS (Orth), Michael Hutton, FRCS (Orth), and Daniel Chan, FRCS (Orth)

Investigation performed at the Peninsula Spine Unit, Princess Elizabeth Orthopaedic Centre, Royal Devon and Exeter Hospital, Exeter, United Kingdom

- Erect XRs test physiological loading and can detect instability
- Consider in cases **except** where instability is already evident





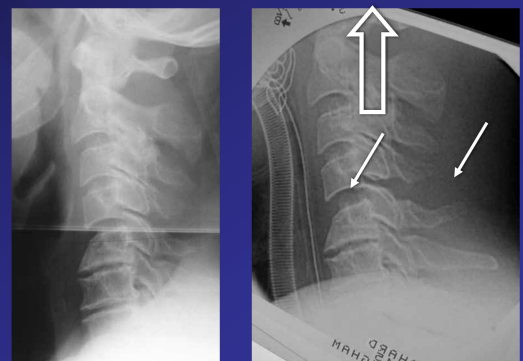
Erect XRs

- Load bearing - physiological
- Normally done in collar
- Useful adjunct after a CT showing a "stable injury" – checks for development of load bearing deformity and ligament injury

Dynamic XRs

- Physiological
- Normally done at 2 weeks post injury to check for stability or after treatment in a collar to ensure no latent instability

Traction Films



Spinal Cord Injury Without Radiological Abnormality (SCIWORA): Is It Still a Notable Definition?

Orhan Buyukbeci^{1*}, Onur Bilge², Burcin Karstli³, Burak Kutluhan Kacira², Harun Kutahya² and Mustafa Isik¹

- **Rare**
 - 0.5% of paediatric spinal trauma
- **SCIWORA**
 - No fracture, no ligament injury, no extraneural compression
 - Oedema/ haemorrhage / infarct / transection / concussion
- **SCIWONA**
 - Nil at all on imaging – prognosis good

Clinical Instability

The loss of the ability of the spine under physiological loads to maintain its pattern of displacement so that there is no initial or additional neurological deficit, no major deformity and no incapacitating pain

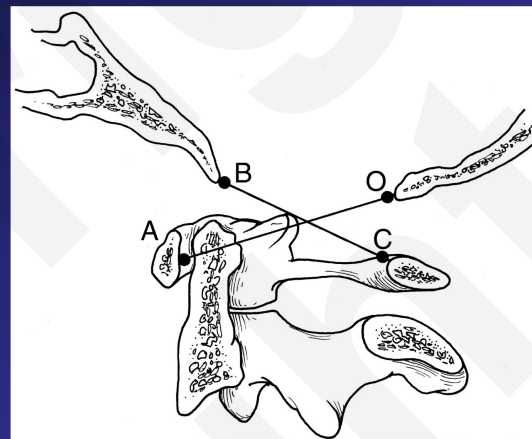
**Mechanical
Neurological**

**Static
Dynamic**



Upper Cervical Instability

- >8° axial rotation C0-1 to one side
- Powers ratio distance BC / OA > 1 (occipito - cervical dislocation)
- Increased odontoid basion distance - the tip of the odontoid should be in line with basion, with the odontoid basion distance 4-5mm adults and up to 10mm in children
- >1mm C0-1 translation in flexion / extension (this is a specialist investigation, not in the acute trauma setting)
- >7mm overhang C1-2 (total left and right)
- >45° axial rotation C1-2 to one side
- Atlantodens interval >5mm (should be <3mm)



Lower Cervical Instability

- Horizontal vertebral body translation >3.5mm or 20%
- Difference in intervertebral angulation between adjacent levels >11°
- Vertebral body height loss
- Disc space >1.7mm
- Facet fracture, subluxation or widening
- Flexion teardrop – small antero-inferior body fracture

Thoracolumbar Instability

- Neurological deficit
- Clinical posterior tenderness or deformity
- > 20-30° kyphosis (segmental or combined)
- > 30% loss of vertebral height (thoracic)
- > 50% loss of vertebral height (lumbar)
- > 50% canal compromise
- Rotational malalignment
- Fracture dislocation
- Multiple adjacent fractures (combined height loss > 50%)
- Scoliosis > 10°

Consequences of SCI

- Inadequate ventilation
- Abdominal evaluation compromised
- Occult compartment syndrome

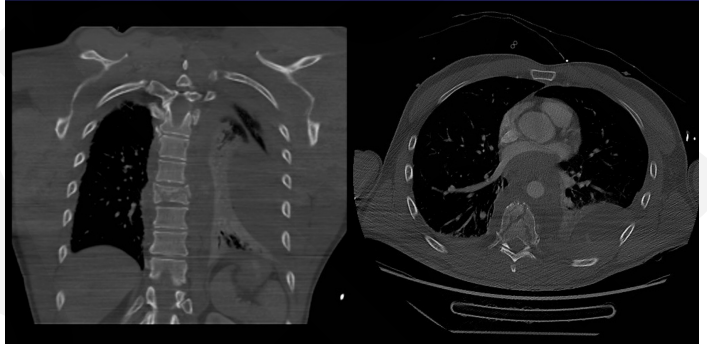
Management of Spinal Injury

- Treat life threatening injuries first
- Ventilation and Oxygenation
- Maintain blood pressure
- Maintain spinal cord perfusion

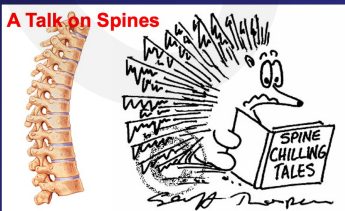
Management of Hypotension

- Haemorrhagic shock until proven otherwise
- Consider neurogenic shock
- Monitor urine output

Hypotensive Bradycardic...



A Talk on Spines



=



Part 2

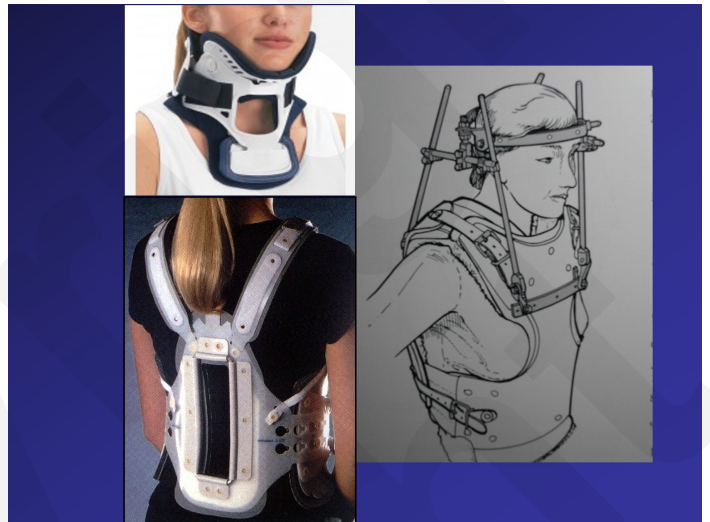
- ✓ Anatomy and Biomechanics of the Spine
- ✓ Pathophysiology of Spinal Cord Injury
- ✓ Investigations
- ✓ Initial Management
- Examples
- Miscellaneous

Principles

- Anatomic Reduction
- Stable Internal Fixation
- Atraumatic Technique
- Early Active Mobilisation / Rehabilitate

**Realign
Stabilize
Decompress – Direct / Indirect
Prevent Late Pain / Deformity**

- Cord Haemorrhage / Oedema / Compression



Spinal Surgery

It's like removing your bendy spine..



DRS – Decompress / Realign / Stabilise

The Personalities

- Personality of the patient
 - Age
 - Comorbidity
 - Bone stock
 - Energy of injury / other injuries
 - Time since injury



The Personalities

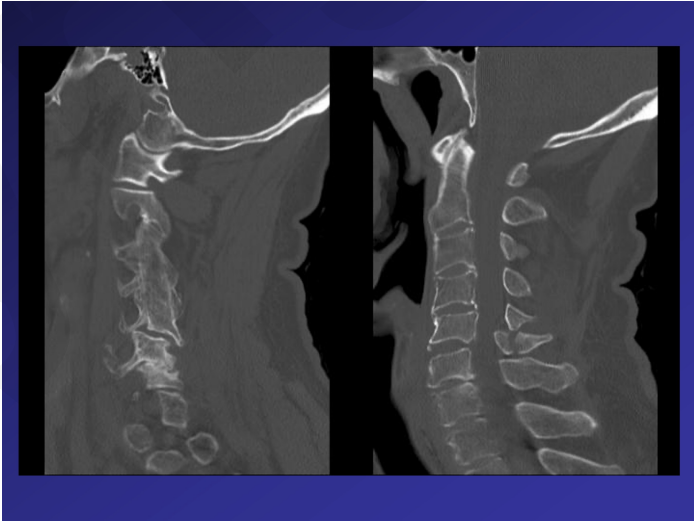
- Personality of the fracture
 - Canal compromise
 - Neurologic compromise
 - Kyphosis
 - Anterior collapse
 - Progression

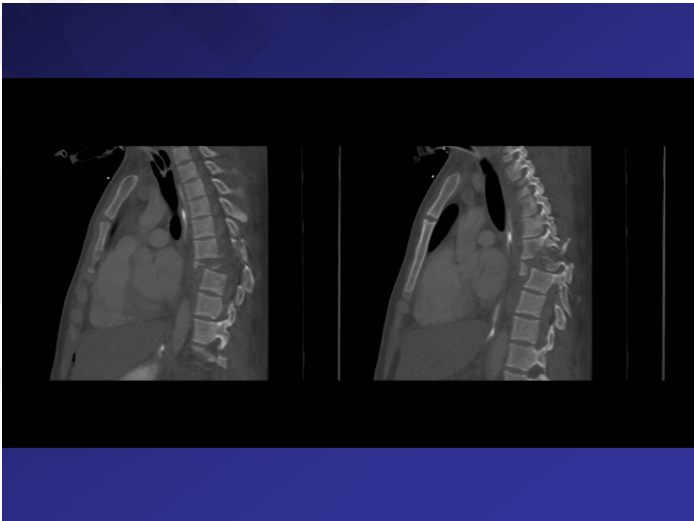
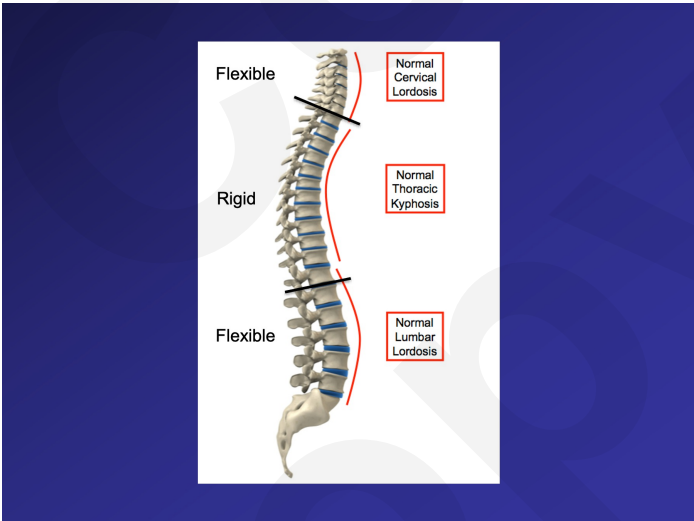
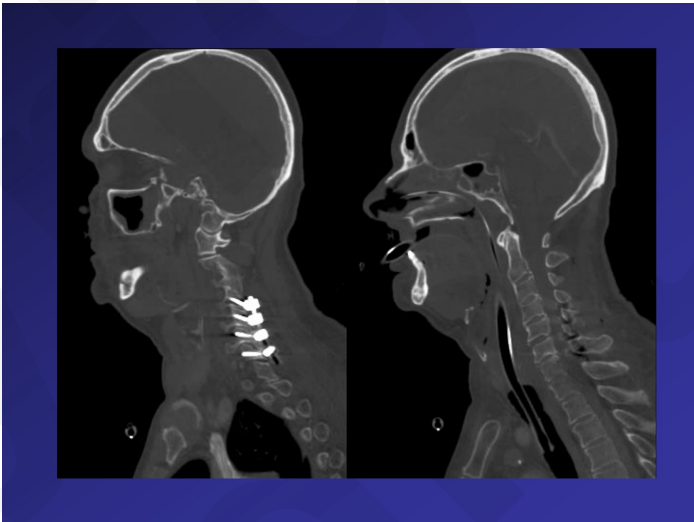
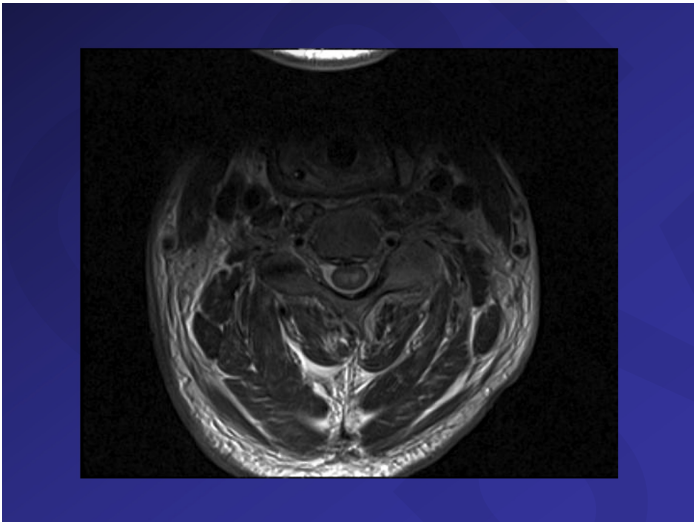
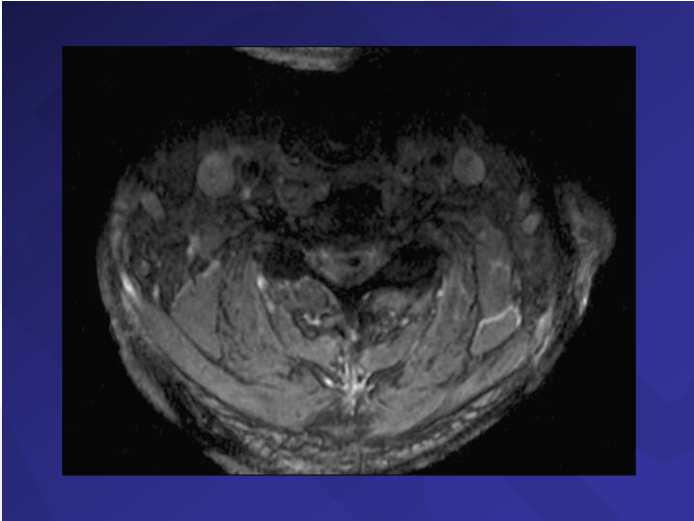
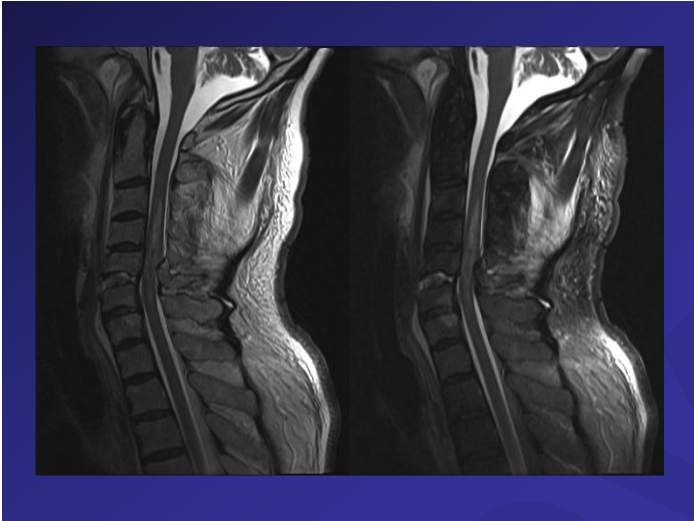


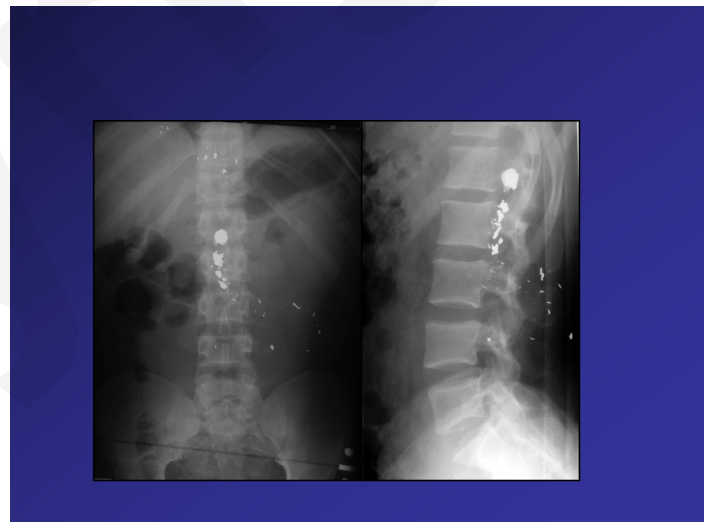
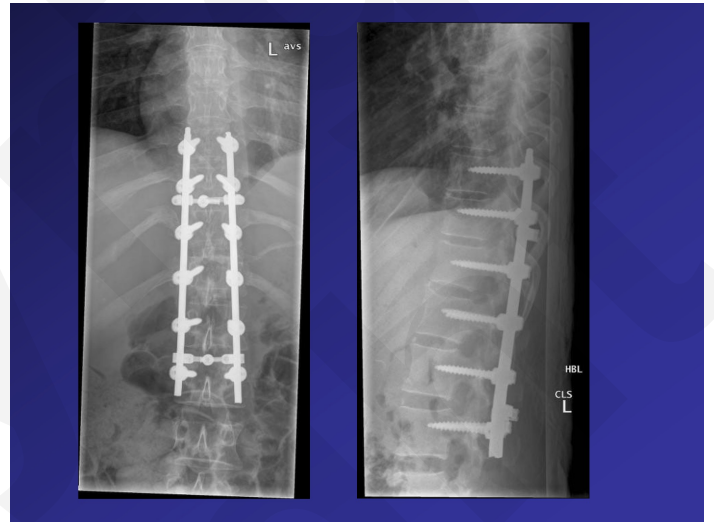
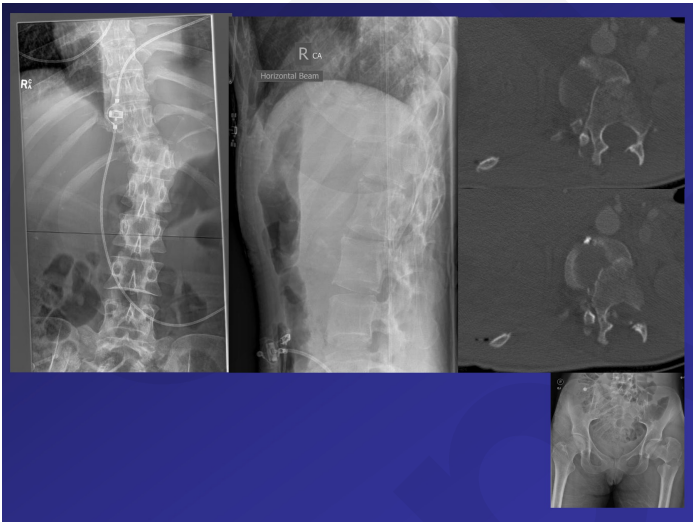
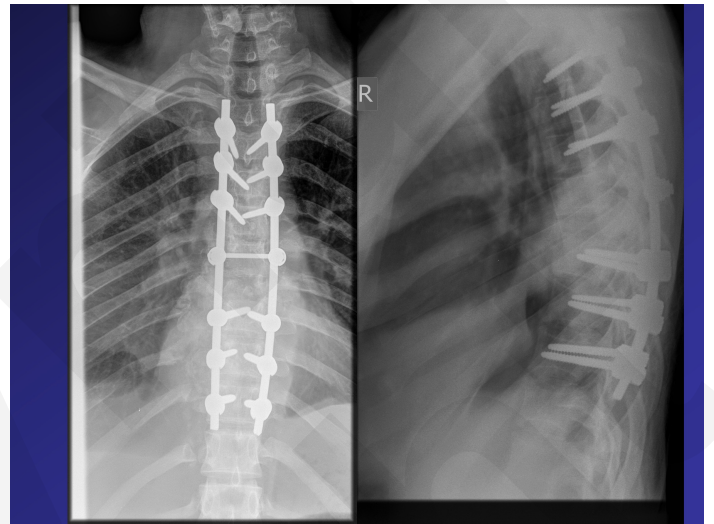
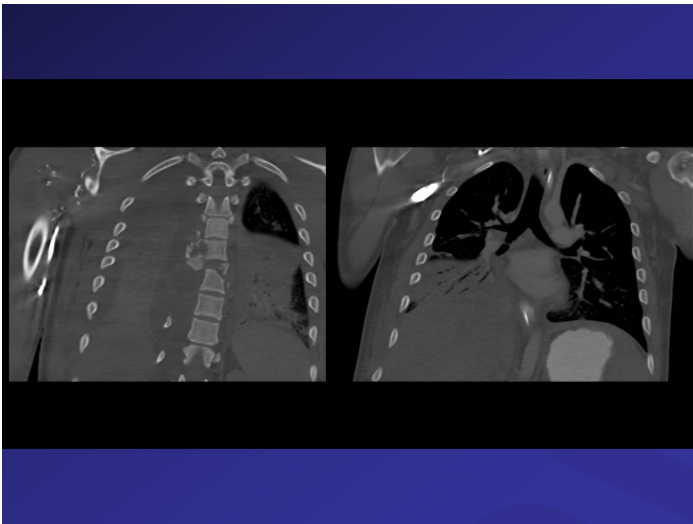
The Personalities

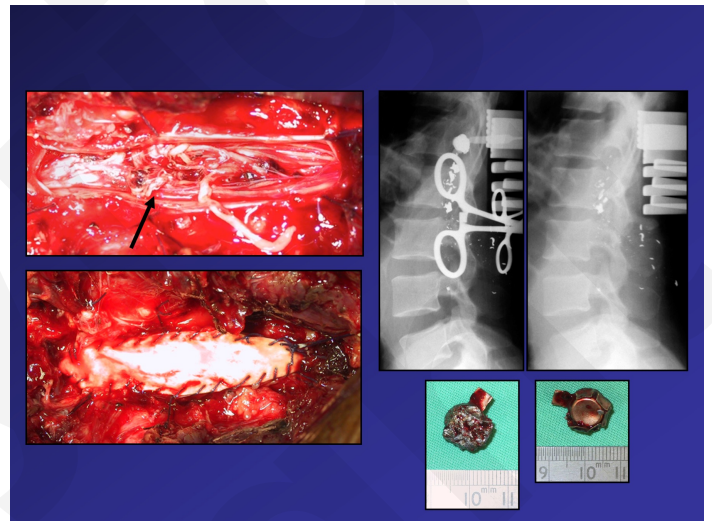
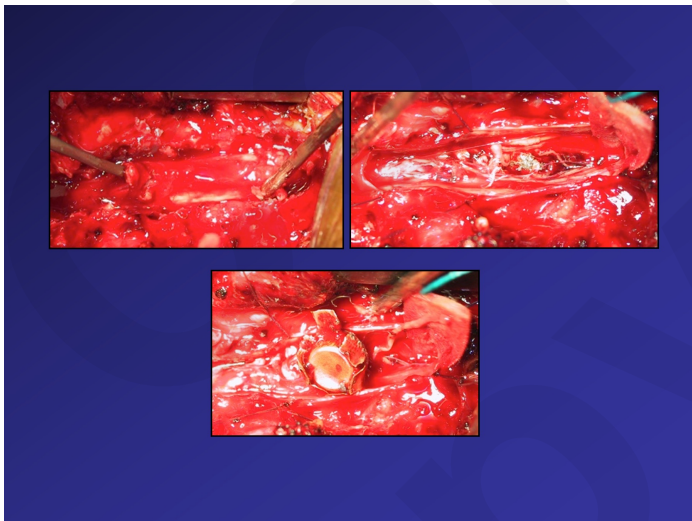
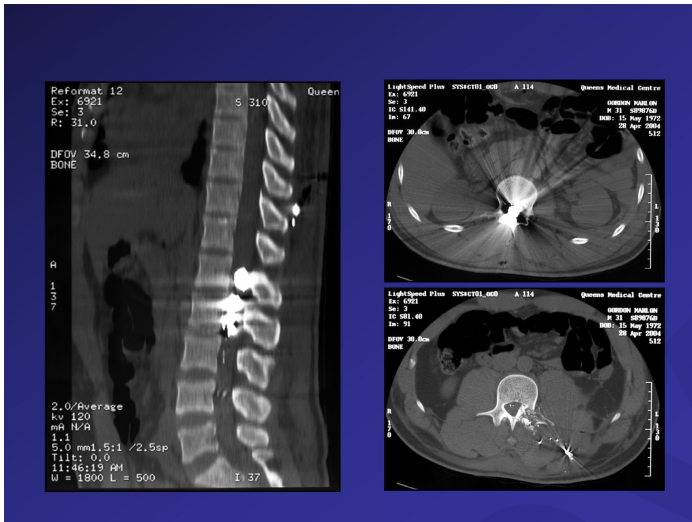
- Personality of the surgeon











Miscellaneous



Timing of Fracture Surgery

Eur Spine J (2013) 22:2157–2166
DOI 10.1007/s00586-012-2624-1

REVIEW ARTICLE

A methodological systematic review of early versus late stabilization of thoracolumbar spine fractures

2014

ORIGINAL ARTICLE

J Trauma Acute Care Surg
Volume 76, Number 2

Early or delayed stabilization in severely injured patients with spinal fractures? Current surgical objectivity according to the Trauma Registry of DGU: Treatment of spine injuries in polytrauma patients

Fix Early esp in Polytrauma

Evidence-based management of central cord syndrome

NADER S. DAHDALEH, M.D., CORT D. LAWTON, B.S., TAREK Y. EL AHMADIEH, M.D.,
ALEXANDER T. NIXON, M.S., NAJIB E. EL TECLE, M.D., SANDERS OH, B.S.,
RICHARD G. FESSLER, M.D., Ph.D., AND ZACHARY A. SMITH, M.D.

Department of Neurological Surgery, Northwestern University, Chicago, Illinois



Management of Acute Traumatic Central Cord Syndrome (ATCCS)

Neurosurgery 72:195–204, 2013

RECOMMENDATIONS

Level III

- Intensive care unit management of patients with acute traumatic central cord syndrome (ATCCS), particularly patients with severe neurological deficits, is recommended.
- Medical management, including cardiac, hemodynamic, and respiratory monitoring, and maintenance of mean arterial blood pressure at 85 to 90 mm Hg for the first week after injury to improve spinal cord perfusion is recommended.
- Early reduction of fracture-dislocation injuries is recommended.
- Surgical decompression of the compressed spinal cord, particularly if the compression is focal and anterior, is recommended.

ITU if severe
Oxygenate
Perfuse
Stabilise instability
Decompress acute compression

Spine

SPINE Volume 40, Number 5, pp 349-356
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SURGERY

Conflicting Evidence – Read the small print

Delayed Surgery After Acute Traumatic Central Cord Syndrome Is Associated With Reduced Mortality

Andre M. Samuel, BBA* Ryan A. Grant, MD, MSt Daniel D. Bohl, MPH* Bryce A. Basques, BS*
Matthew L. Webb, AB* Adam M. Lukasiewicz, MSc* Pablo J. Diaz-Collado, MD* and Jonathan N. Grauer, MD*

Conclusion. Although the potential neurological effect of surgical timing for patients with ATCCS remains controversial, the decreased mortality with delayed surgery suggests that waiting to optimize general health and potentially allow for some spinal cord recovery in these patients may be advantageous.

Acute Traumatic CCS

- Early surgery if:
 - Fracture / Dislocation / Instability
 - Acute compression
 - Acute disc prolapse
 - Haematoma
- Evidence to lie flat for 6 weeks then tilt table to allow cord to recover
 - ?Rapid / Slow recovery
 - ?Dense / Mild deficit

Flat Bed Rest Following SCI?

Trauma 2006; 8: 29–46

Traumatic spinal cord injury: the relationship between pathology and clinical implications

WS El Masri(y)

- Documented evidence of further neurological deterioration with postural hypotension
- Early mobilization can reduce vital capacity and impair the cord further
- Do tilt table studies as cord recovers
- 6/52 flat bed rest for cervical cord injuries

Spine

SPINE Volume 40, Number 5, pp 299-304
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CLINICAL CASE SERIES

Early Pharmacological Venous Thromboembolism Prophylaxis Is Safe After Operative Fixation of Traumatic Spine Fractures

Dennis Yong Kim, MD, FACS, Leslie Kobayashi, MD, FACS, David Chang, MPH, MBA, PhD, Dale Fortlage, BA, and Raul Coimbra, MD, PhD, FACS

Conclusion. Pharmacological VTE prophylaxis initiated within 48 hours of operative fixation of traumatic spine fractures seems to be safe and is not associated with an increased risk of bleeding or neurological complications. Large, multicenter prospective studies are required to further define the efficacy and safety of an early pharmacological VTE prophylaxis strategy in this at-risk patient population.

The Future is Coming



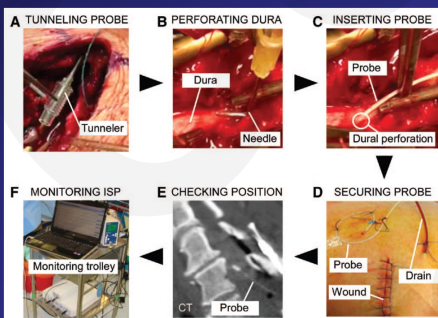
Hypothermia for Acute Spinal Cord Injury—A Review

Faiz U. Ahmad, Michael Y. Wang, Allan D. Levi

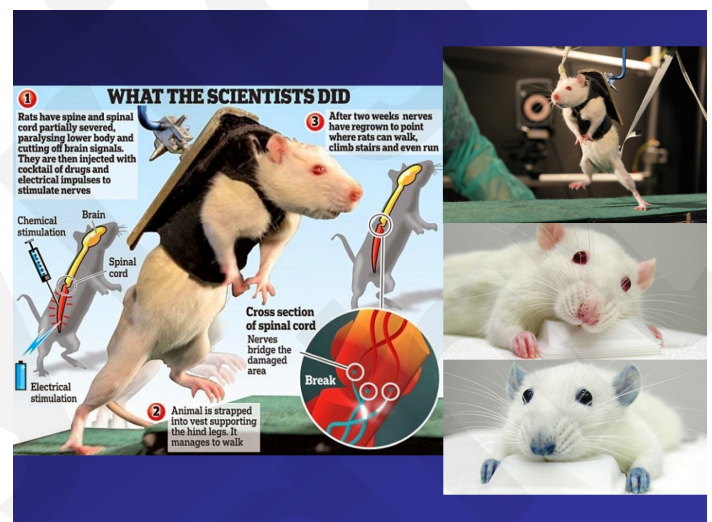
CONCLUSIONS: There is robust experimental and some clinical evidence that hypothermia is beneficial in acute SCI. Larger, multicenter trials should be initiated to further study the usefulness of systemic hypothermia in SCI.



Monitoring of Spinal Cord Perfusion Pressure in Acute Spinal Cord Injury: Initial Findings of the Injured Spinal Cord Pressure Evaluation Study*



- Subdural ISP – cf ICP
- SSCP – cf CPP
- Laminectomy – no difference



Complications

- Pneumonia
- Postural Hypotension
- DVT / PE
- Autonomic Dysreflexia
- Renal Failure
- Pseudo-obstruction
- Sexual Dysfunction
- Pressure Sores
- Psychological Problems

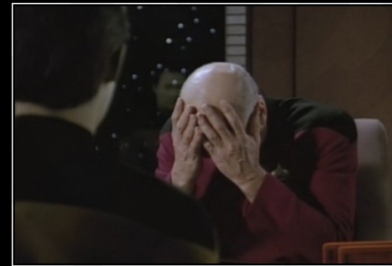
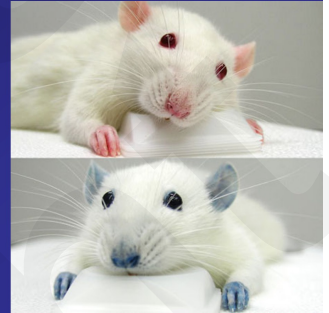
Outcomes Paralysis

- 25yr tetraplegic >60% normal life expectancy (level below C5)
- 25yr paraplegic >80% normal life expectancy
- 25yr partial paraplegic with mobility >85% normal life expectancy
- 90% of patients with complete tetraplegia will recover some level of function in the muscles below the neurologic level of injury
- MRC 1-2/5 at 30 days have 97% chance progressing to 3/5 at 1 year
- MRC 0/5 at 30 days only 57% recover to 1/5 and 27% to 3/5 at 1 year
- 80% of patients with incomplete paraplegia recover to grade 3/5 in their hip flexors and knee extensors at 1 year (enough to stand with aids)



Summary

- Remember ABCDE / ATLS
 - Treat life threatening injuries first
- Protect then Detect
- Think second injury



FACEPALM

When words fail to describe the dismay, there is always Facepalm.

- www.spinedragon.com
- Your email
- Password = OrangeMoon



Facet Dislocation Algorithm 1

- After CT Dx d/w t/f to Spinal Surgeon ASAP
- **No Neurological Deficit**
 - MRI
 - No Disc Lesion
 - Closed reduction by sequential traction then urgent op
 - Urgent / Emergent op if evolving neurological deficit
 - Disc Lesion
 - Urgent / Emergent op
- Recovery $\propto$ duration

Realign
Stabilize
Decompress – Direct / Indirect
Prevent Late Pain / Deformity

Facet Dislocation Algorithm 2

- After CT Dx d/w t/f to Spinal Surgeon ASAP
- **Partial Neurological Deficit / Obtunded**
 - MRI
 - No Disc Lesion
 - Closed reduction by sequential traction then urgent / emergent operation
 - Disc Lesion
 - Urgent / emergent operation
- **Recovery α duration**

Realign
Stabilize
Decompress – Direct / Indirect
Prevent Late Pain / Deformity

Facet Dislocation Algorithm 3

- After CT Dx d/w t/f to Spinal Surgeon ASAP
- **Complete Neurological Deficit**
 - Is there any need for MRI?
 - Prognostic / surgical planning
 - Attempt at closed reduction?
 - Surgical facilities not immediately available
 - Emergency Operation
- **Recovery α duration**

Realign
Stabilize
Decompress – Direct / Indirect
Prevent Late Pain / Deformity