

Central cord syndrome

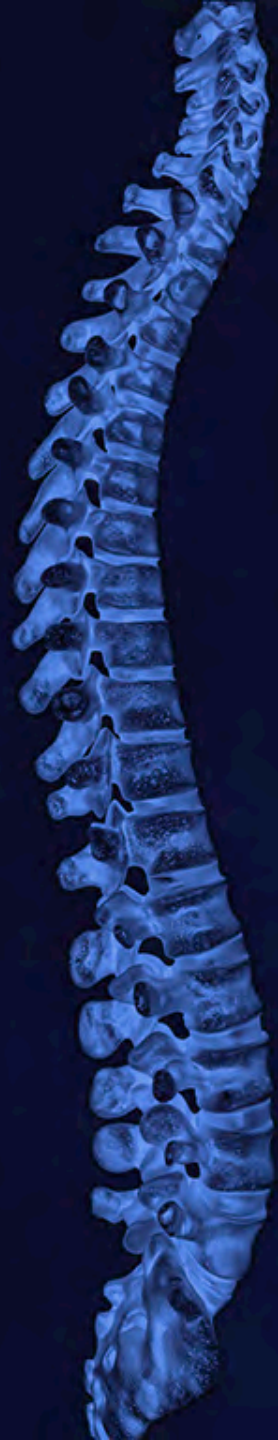
Laura Snyder, MD FAANS

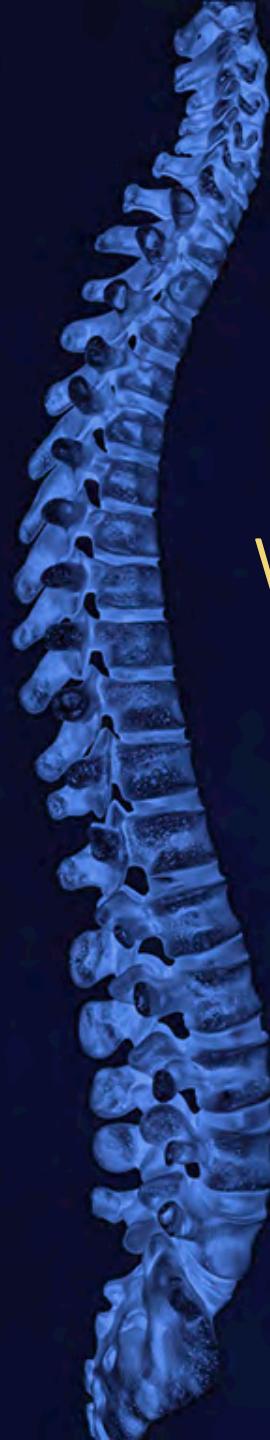
Director of Neurotrauma

Minimally Invasive Spine Surgeon

Barrow Neurological Institute

St. Joseph's Hospital and Medical Center





Where does central cord syndrome
fit into the spinal cord injury
spectrum?

Spinal Cord Injury

- Complete
 - No preservation of any motor and/or sensory function more than 3 segments below the level of injury in the absence of spinal shock
- Incomplete
 - Some preservation of motor and/or sensory function below level of injury including
 - Palpable or visible muscle contraction
 - Perianal sensation
 - Voluntary anal contraction

Incomplete Spinal Cord Injury

- Central cord syndrome
- Anterior cord syndrome
- Brown-Sequard syndrome
- Posterior Cord Syndrome

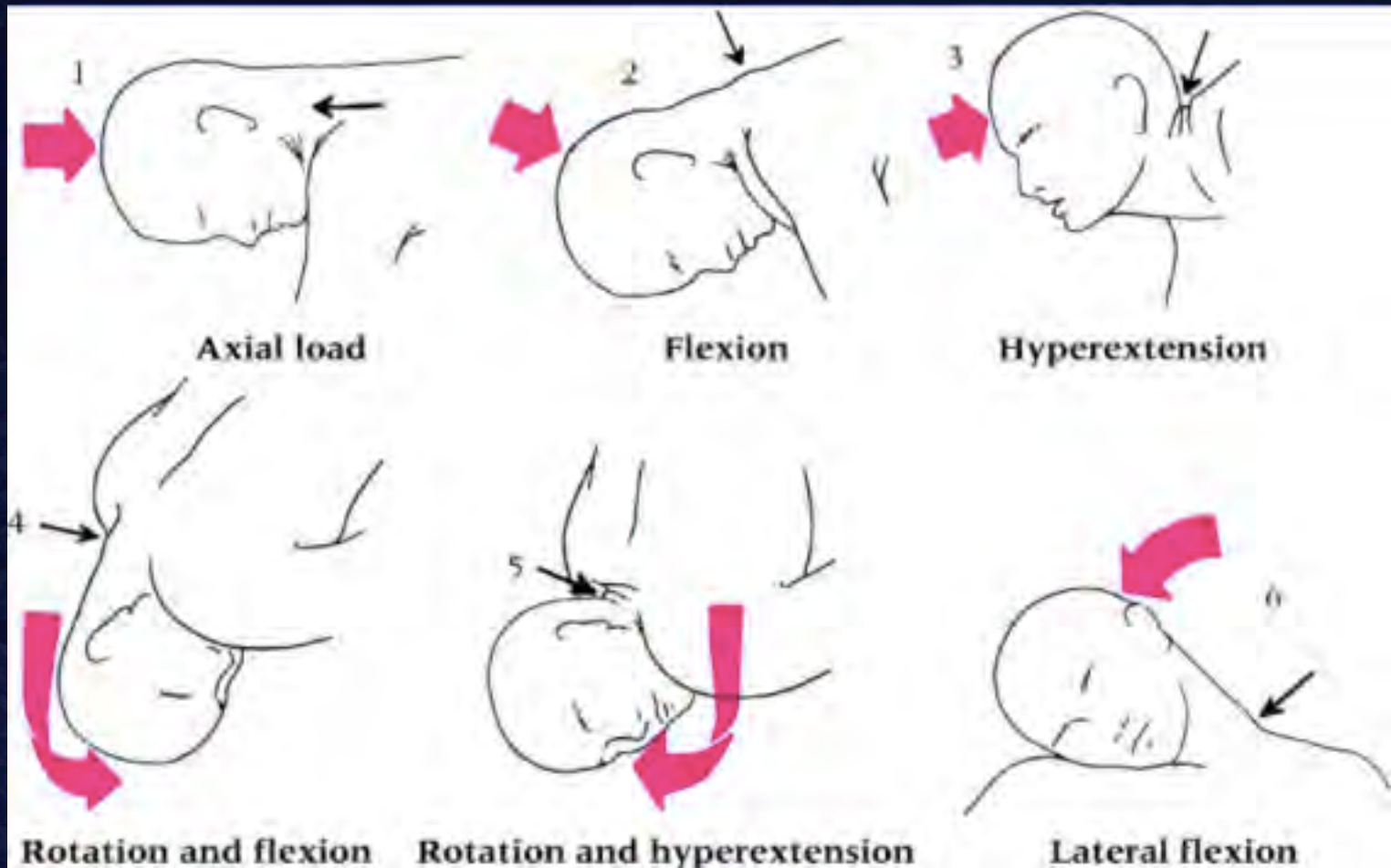
Spinal Cord Injury Epidemiology

- 11,000 cases/year
- 34% incomplete tetraplegia
 - Most common is Central Cord Syndrome
- 11% incomplete paraplegia
- 47% complete injuries

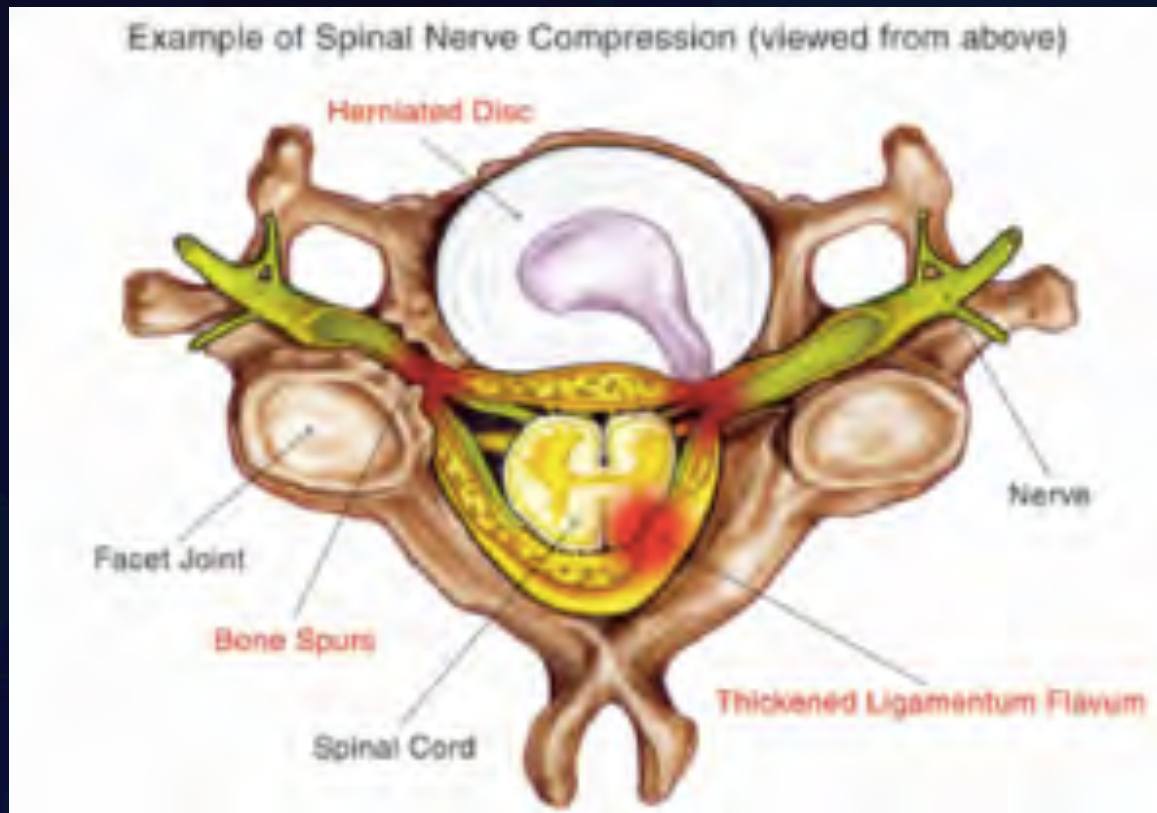
The Cause

- Most commonly acute hyperextension injury in older patient with pre-existing acquired stenosis
- Stenosis can be result of
 - Bony hypertrophy (anterior or posterior spurs)
 - Infolding of redundant ligamentum flavum posteriorly
 - Anterior disc bulge or herniation
 - Congenital spinal stenosis

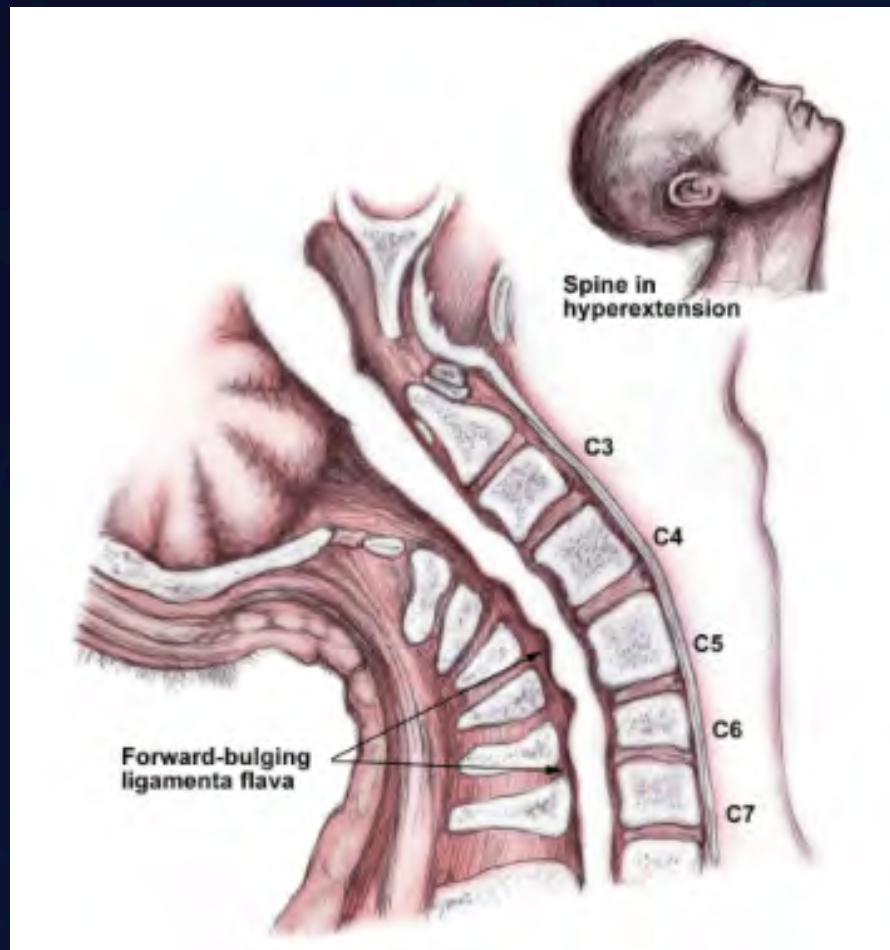
Abnormal Loading of Spinal Cord can cause Spinal Cord Injury



Nerve Compression at Rest



Combine pre-existing compression
with hyperextension =>
Central Cord Syndrome

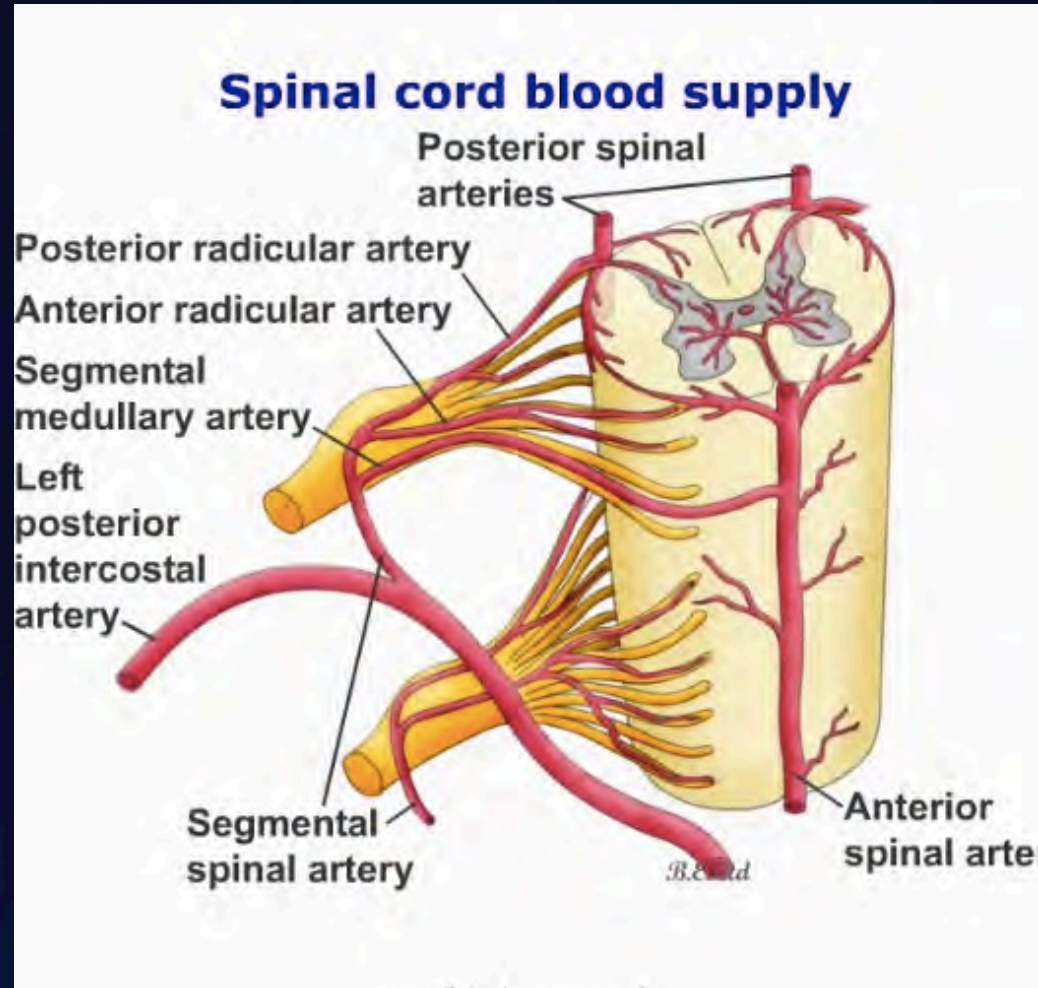


Most Common Presentation

- Blow to upper face or forehead
- Forward fall (anytime you see an elderly patient with a fall in which they hit their head)
- Motor Vehicle accident
- Sporting injuries

Pathomechanics

- Centermost region of spinal cord is vascular watershed zone
- Leaves it more susceptible to injury from edema



Pathomechanics

- Long tract fibers passing through the cervical spinal cord are somatotopically organized such that cervical fibers are located more medially than the fibers serving the lower extremities

Pathomechanics

Descending Tracts (Motor)

Lateral Corticospinal Tract (Motor)

Hand Motor Pathway
is central
Region of Central Cord
Syndrome

Lateral Corticospinal Tract (Motor)

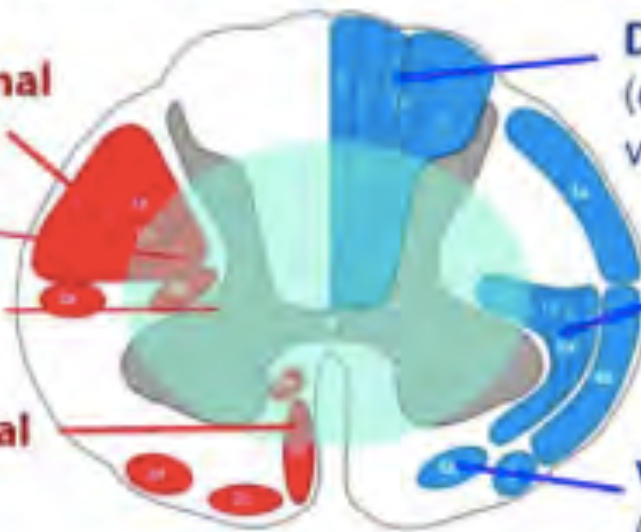
Ascending Tracts (Sensory)

Dorsal Columns

(deep touch, proprioception,
vibration)

Lateral Spinothalamic Tract (pain and temperature)

Ventral Spinothalamic Tract (light touch)



Clinical Presentation

- Motor weakness of upper extremities with lesser effect on lower extremities
- Hands with more dysfunction than arms
- Varying degrees of sensory disturbances
- Myelopathic signs such as sphincter dysfunction, usually urinary retention
- Sacral Sparing

Hyperpathia

- Burning sensitivity to noxious and non-noxious stimuli
- Worse in upper extremities
- Can be delayed in onset
- Very distressing to patient
- Severe hand pain can be common

If Late Clinical Presentation

- Upper extremities have lower motor nerve signs of dysfunction
 - Clumsy in the hands, some “clawing” of the hands
- Lower extremities have upper motor nerve signs of dysfunction
 - Spasticity and clonus in the legs

Prognosis

- Good chance for recovery but full functional recovery rare
- Severity of initial presentation is best indicator for how far one can progress
- Usually recover ambulatory function and bladder control but can take months
- Upper extremity and hand recovery unpredictable, often clumsy hands permanent

Recovery Pattern

- Lower extremities recover first
- Bowel and bladder function second
- Proximal upper extremity after
- Hand function last to recover

71 year old male who fell

- Severe neck pain
- Difficulty using his hands, difficulty grasping utensils and buttoning
- Decreased proprioception in bringing his arms up, feels his arms are “flailing”
- Difficulty standing on own, feeling he will fall

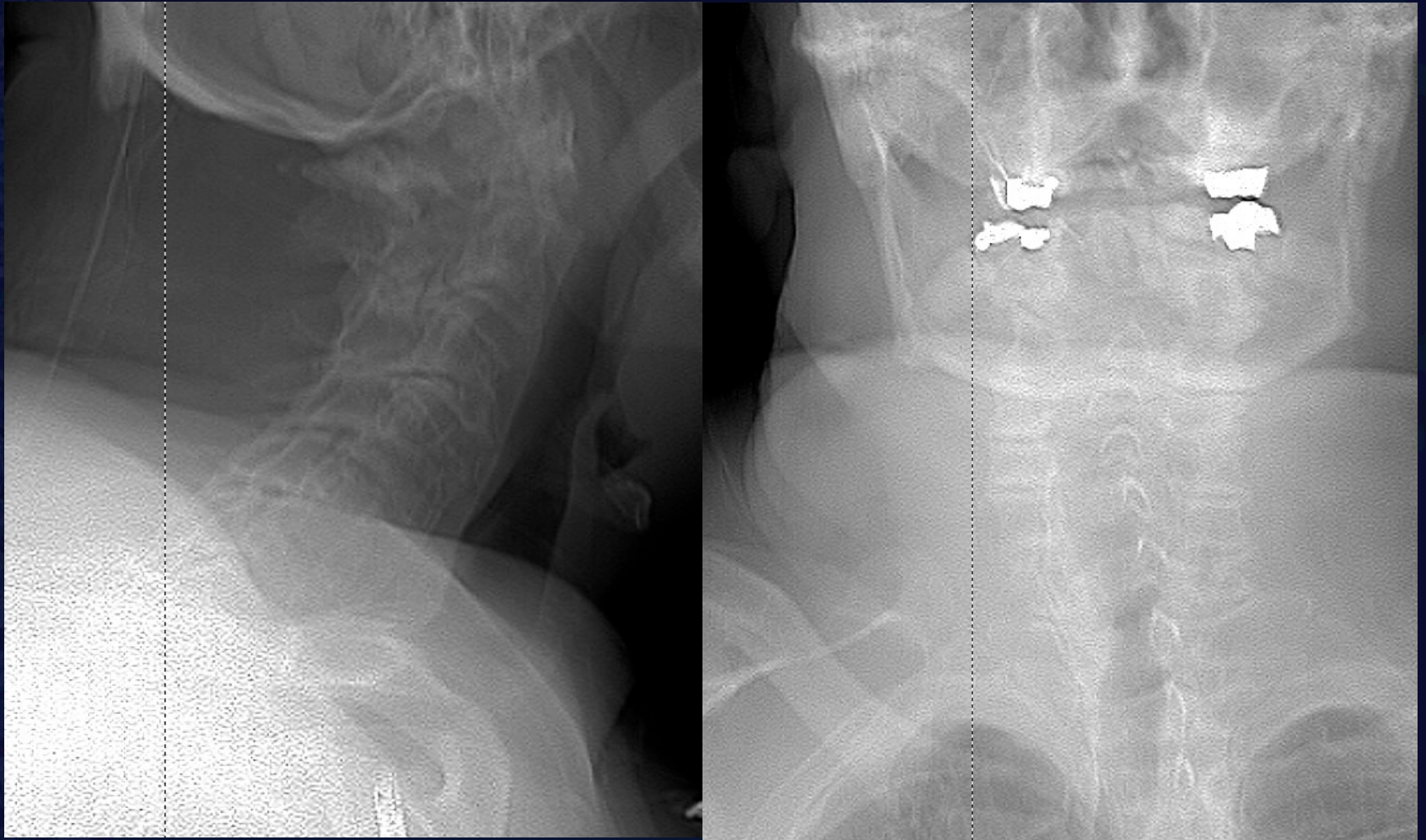
Imaging

- Young patients more likely to have disc protrusion, subluxation, dislocation or fractures
- Older patients more likely to have multi-segment canal narrowing due to osteophytes, discs, and buckling of ligamentum flavum

X-rays

- May suggest congenital narrowing, osteophytic spurs, traumatic fracture
- Will fail to demonstrate canal narrowing due to buckling of ligamentum flavum, facet hypertrophy, disc herniation, poorly calcified osteophytic spurs

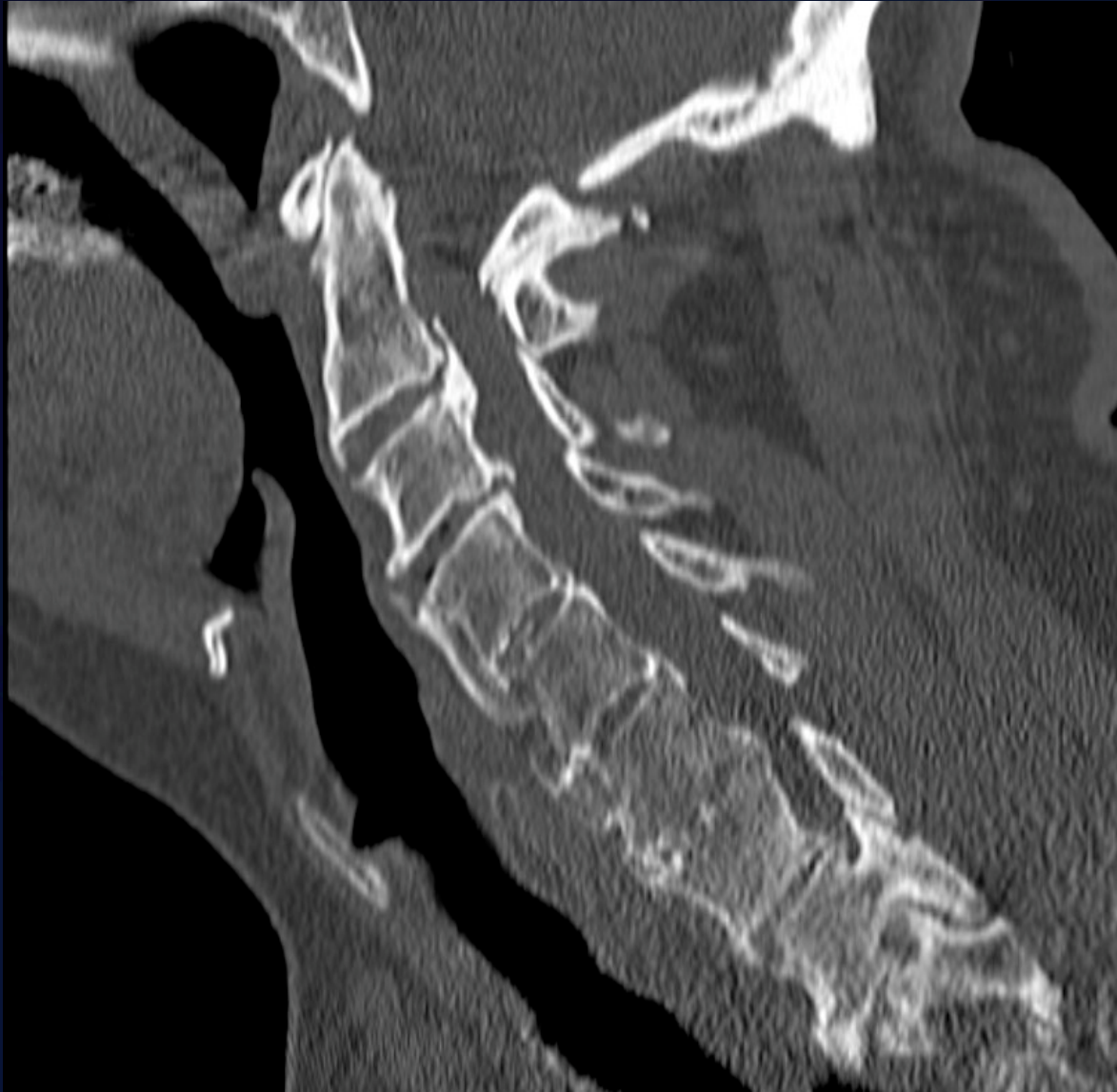
Case JC



CT scan

- Best for diagnosing bony fractures and osteophytic spurs
- Can also identify congenital canal stenosis
- Still cannot assess well integrity of the discs, spinal cord, and extent of ligamentous contribution to stenosis

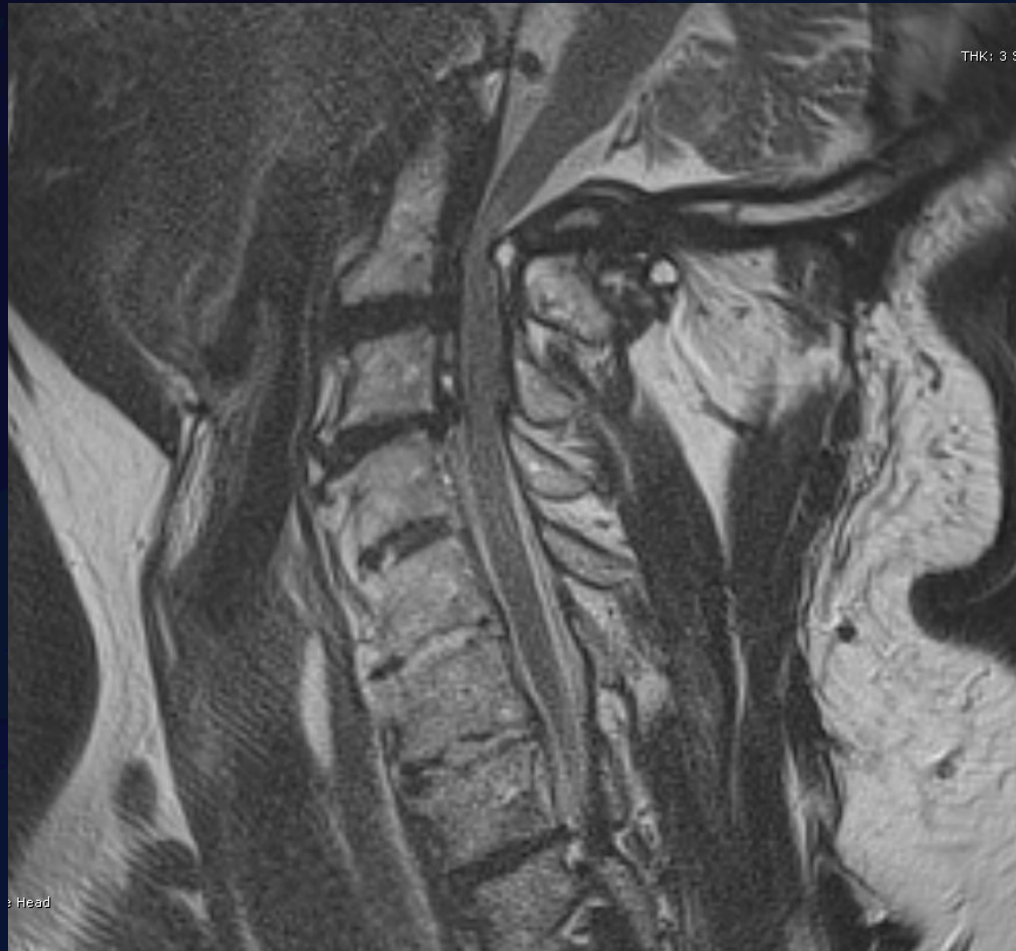
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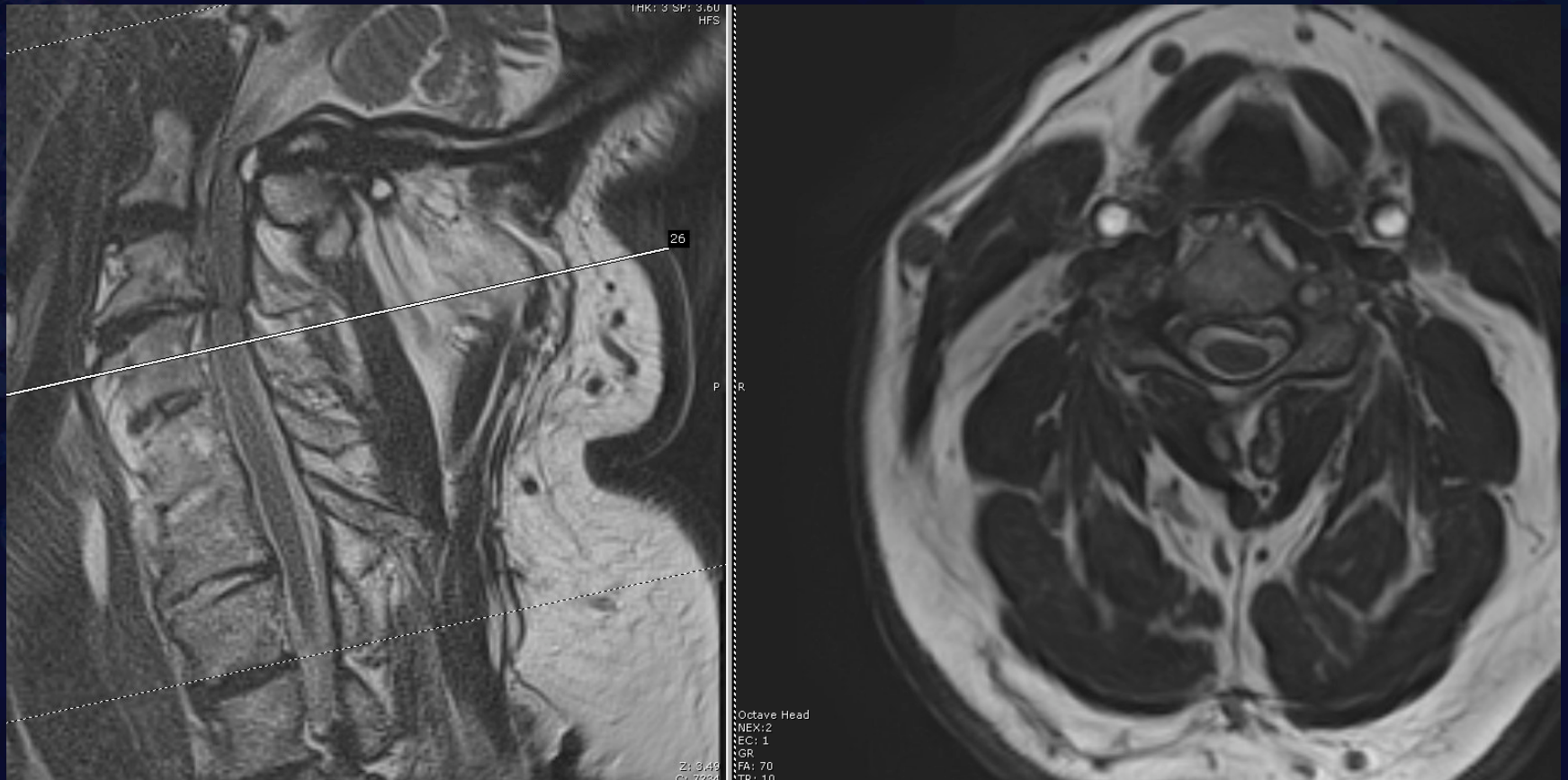
MRI scan

- Best for assessing extent of canal compromise and compression of the spinal cord
- Also identifies disc herniations and ligamentum flavum overgrowth
- Bright signal within the spinal cord on T2 imaging suggests edema within the spinal cord suggesting injury
- Poor for identifying fractures

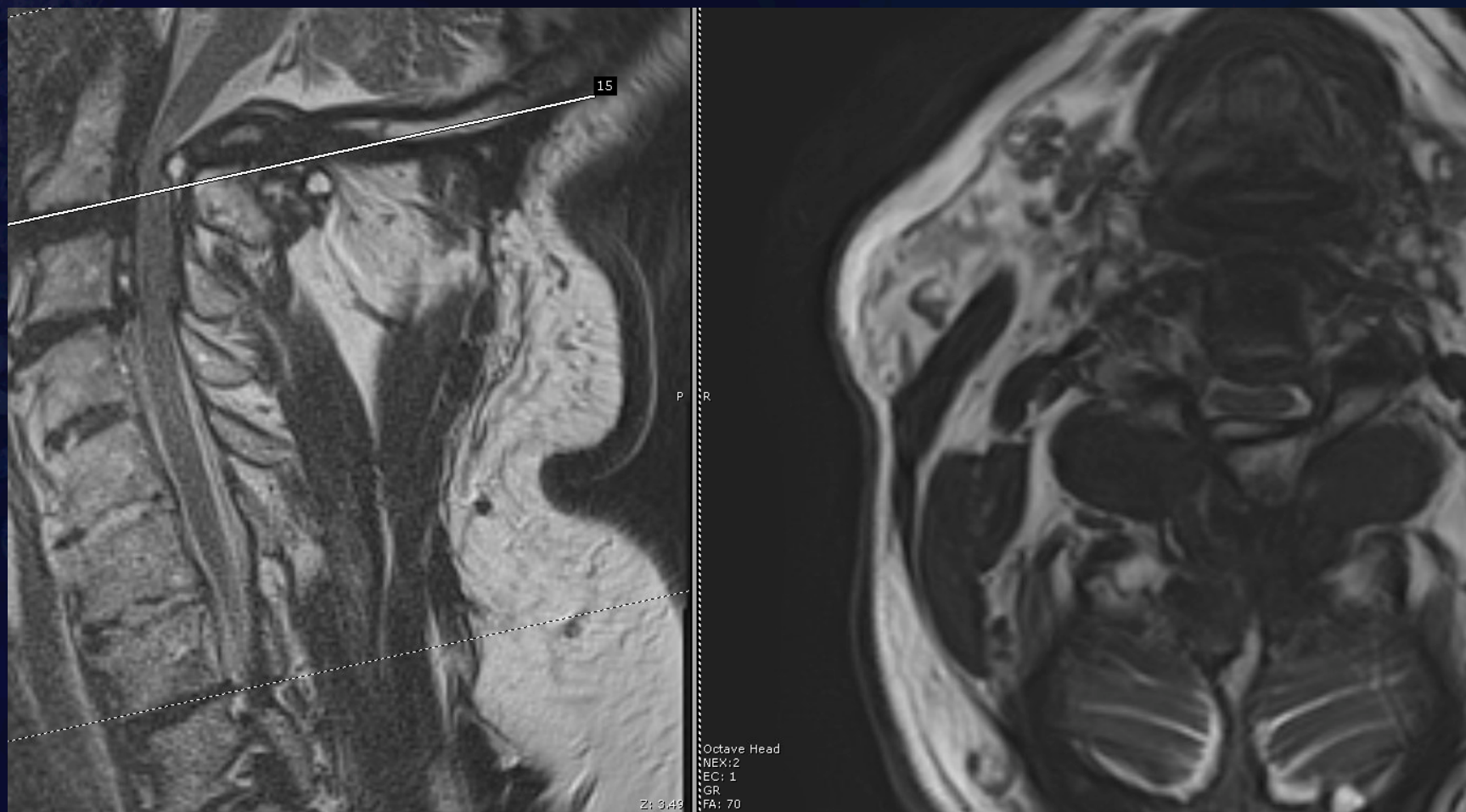
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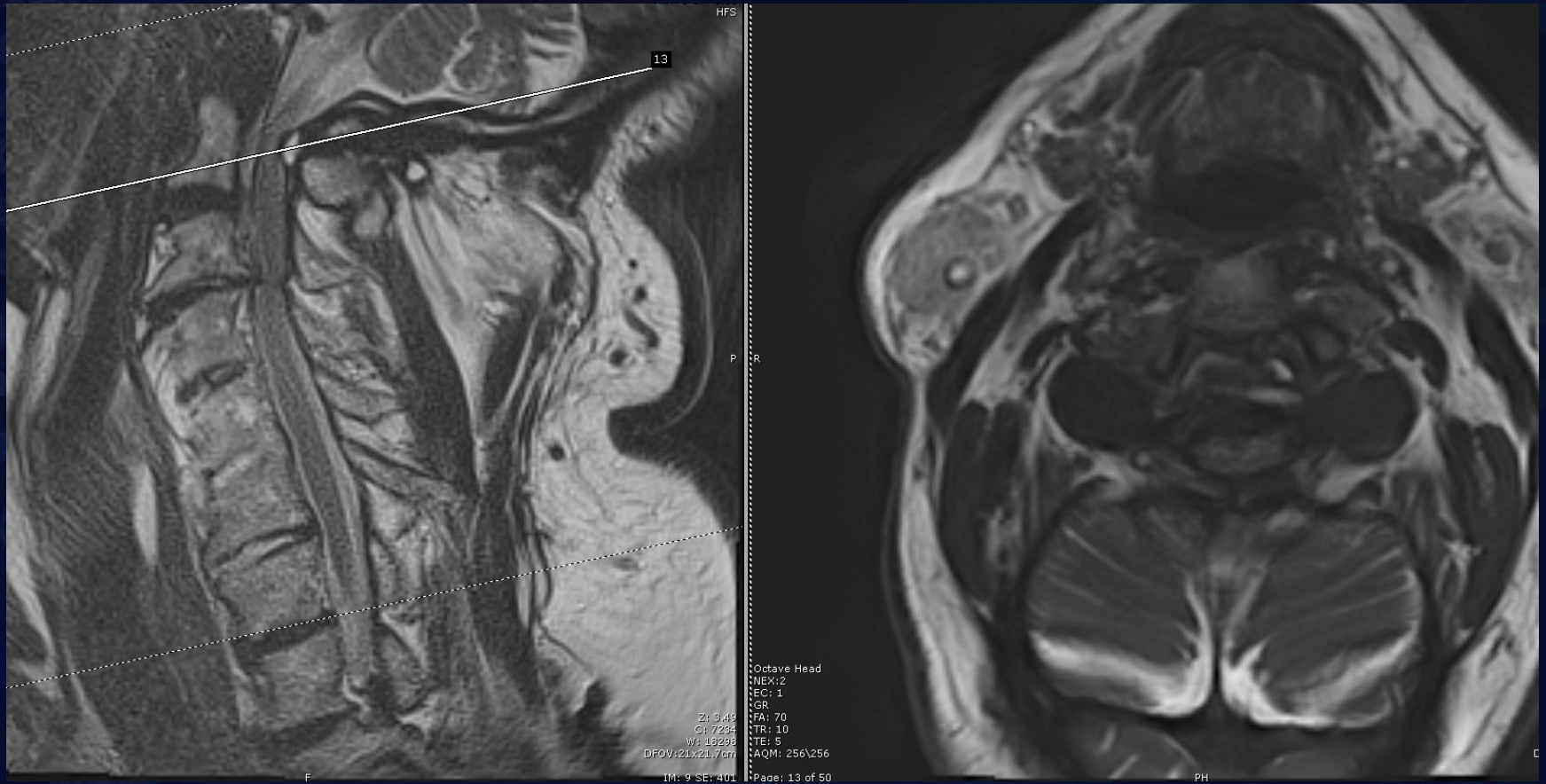
Case JC



Case JC



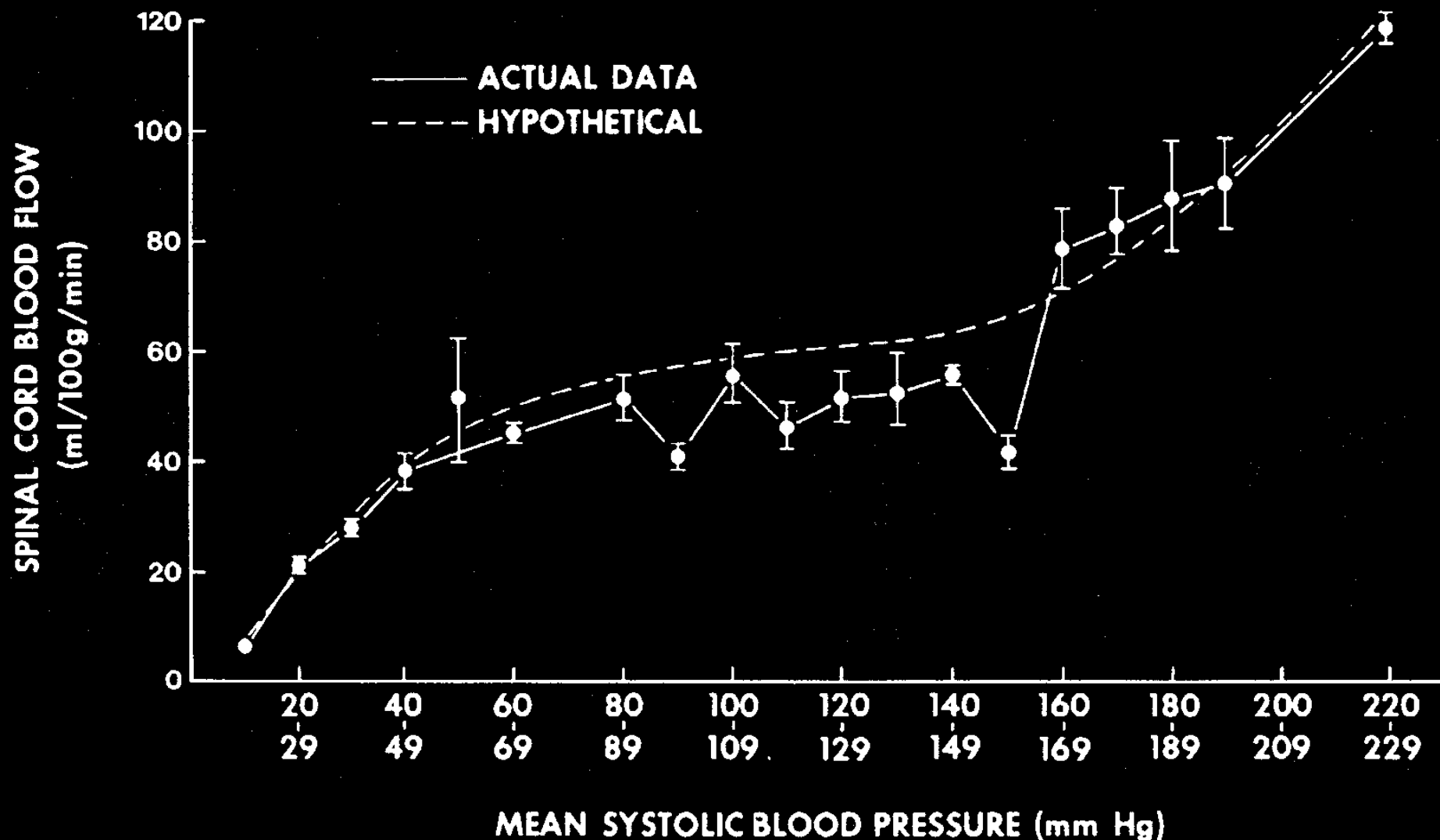
Case JC



Management of Acute Central Cord Syndrome Injuries

- Admission to ICU
- Require close monitoring due to possible cardiac, pulmonary, and blood pressure disturbances
- Maintenance of Mean Arterial Pressure 85-90 mm Hg to prevent secondary injury by hypoperfusion
- Surgical decompression of compressed spinal cord and stabilization of instability

Maintain the systolic blood pressure to prevent further injury and promote recovery

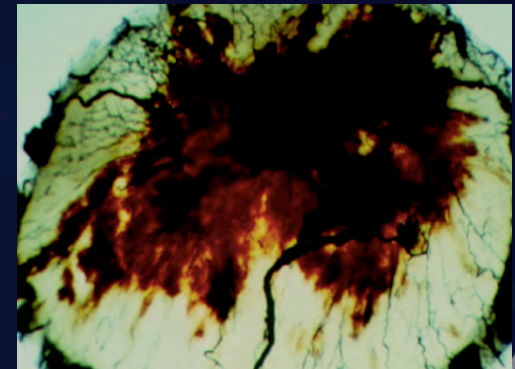


Levi et al., Neurosurgery 1993

- Prospective study of 50 patients who underwent spinal immobilization or fixation as indicated
- MAP goal >90 mm Hg maintained 1st week after injury
- 82% of patients showed stable or improved neurological function at 6-week follow-up as measured by their Frankel grade
- No control group

Vale et al., J Neurosurgery 1997

- Prospective study of 64 cervical and thoracic SCI patients
- Vigorous maintenance of MAP > 85 mmHg
- Minimum of 7 days post-injury
- Better neurological recovery than historical control



Type of Vasopressor

- Dopamine and phenylephrine historically the primary vasopressors used in SCI
- Epinephrine and dobutamine avoided due to cardiac side effects
- Norepinephrine historically a second- or third-line agent

Saadeh et al, Neurosurgical Focus
2017

Type of Vasopressor

- Increasing interest and use of norepinephrine as the vasopressor of choice for SCI due to the demonstrated higher complication rate associated with dopamine use in SCI patients
- Increasing evidence in the intensive care unit literature showing dopamine associated with a greater mortality rate as well as being more arrhythmogenic when compared with other vasopressors

The National Acute Spinal Cord Injury Studies (NASCIS)

JAMA
THE JOURNAL of the
American Medical Association
Jan 6, 1984 Vol 251, No. 1

Efficacy of Methylprednisolone in Acute Spinal Cord Injury

Michael B. Bracken, PhD; William F. Collins, MD; Daniel F. Freeman, PhD; Mary Jo Shepard, MPH;
Franklin W. Wagner, MD; Robert M. Silten, MPH; Karen G. Hellenbrand, MPH; Joseph Ransohoff, MD;
William E. Hunt, MD; Phaner L. Perot, Jr, MD; Robert G. Grossman, MD; Barth A. Green, MD;
Howard M. Eisenberg, MD; Nathan Rifkinson, MD; Joseph H. Goodman, MD; John N. Meagher, MD;
Boguslav Fischer, MD; Guy L. Clifton, MD; Eugene S. Flamm, MD; Stephen E. Rawe, MD

NASCIS 1 (Jan, 1984)

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Number 20

A RANDOMIZED, CONTROLLED TRIAL OF METHYLPREDNISOLONE OR NALOXONE IN THE TREATMENT OF ACUTE SPINAL-CORD INJURY

Results of the Second National Acute Spinal Cord Injury Study

MICHAEL B. BRACKEN, PH.D., MARY JO SHEPARD, M.P.H., WILLIAM F. COLLINS, M.D.,
THEODORE R. HOLFORD, PH.D., WISE YOUNG, M.D., DAVID S. BASKIN, M.D.,
HOWARD M. EISENBERG, M.D., EUGENE FLAMM, M.D., LINDA LEO-SUMMERS, M.P.H., JOSEPH MAROON, M.D.,
LAWRENCE F. MARSHALL, M.D., PHANOR L. PEROT, JR., M.D., JOSEPH PIEPMEIER, M.D.,
VOLKER K.H. SONNTAG, M.D., FRANKLIN C. WAGNER, M.D., JACK E. WILBERGER, M.D.,
AND H. RICHARD WINN, M.D.

NASCIS 2 (May, 1990)

JAMA, May 28, 1997—Vol 277, No. 20

Administration of Methylprednisolone for 24 or 48 Hours or Tirilazad Mesylate for 48 Hours in the Treatment of Acute Spinal Cord Injury

Results of the Third National Acute Spinal Cord Injury Randomized Controlled Trial

Michael B. Bracken, PhD; Mary Jo Shepard, MPH; Theodore R. Holford, PhD; Linda Leo-Summers, MPH;
E. Francois Aldrich, MD; Mahmood Fazl, MD; Michael Fehlings, MD, PhD; Daniel L. Herr, MD; Patrick W. Hitchon, MD;
Lawrence F. Marshall, MD; Russ P. Nockels, MD; Valentine Pascale, RPh; Phanor L. Perot, Jr, MD, PhD;
Joseph Piepmeier, MD; Volker K. H. Sonntag, MD; Franklin Wagner, MD; Jack E. Wilberger, MD;
H. Richard Winn, MD; Wise Young, MD, PhD; for the National Acute Spinal Cord Injury Study

NASCIS 3 (May, 1997)

J Neurosurg (Spine 1) 93:1-7, 2000

Methylprednisolone for acute spinal cord injury: an inappropriate standard of care*

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J Spinal Disord, Vol. 13, No. 3, 2000

A Critical Appraisal of the Reporting of the National Acute Spinal Cord Injury Studies (II and III) of Methylprednisolone in Acute Spinal Cord Injury

William P. Coleman, *Edward Benzel, †David W. Cahill, ‡Thomas Ducker, §Fred Geisler,
||Barth Green, §Mitchell R. Gropper, ¶Jan Goffin, **Parley W. Madsen III, ††Dennis J. Maiman,
‡‡Stephen L. Ondra, §§Michael Rosner, ||||Rick C. Sasso, ¶¶Gregory R. Trost, and ***Seth Zeidman

Spinal Cord (2000) 38, 273-286

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Scientific Review

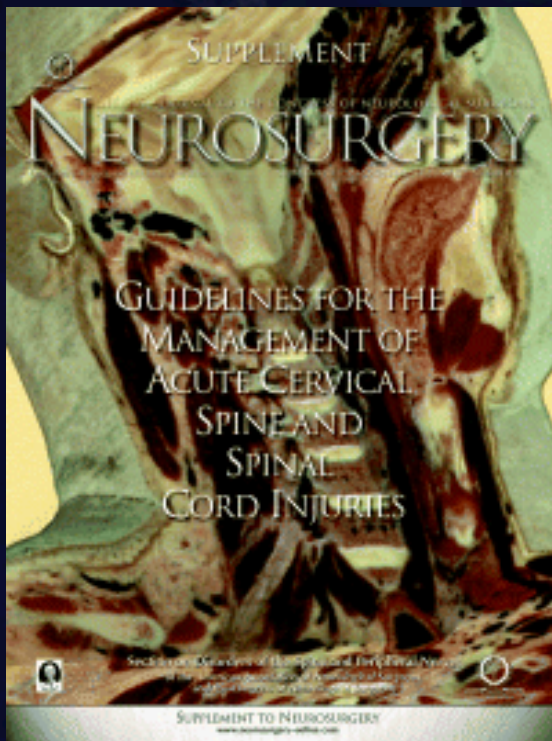
High dose methylprednisolone in the management of acute spinal cord injury – a systematic review from a clinical perspective

DJ Short^{*1}, WS El Masry^{1,3} and PW Jones^{2,4}

¹Midlands Centre for Spinal Injuries, Robert Jones & Agnes Hunt Orthopaedic & District Hospital NHS Trust,
Oswestry, Shropshire, SY10 9DP, UK; ²Department of Mathematics, Keele University, Staffordshire, ST5 5BG, UK

Debating the Merits of Methylprednisolone

Severe criticism of NASCIS II and III, and other human studies of methylprednisolone.



CHAPTER 9

This chapter remains the most controversial of the Guidelines. The readers are advised to carefully review the available data and Comments provided within this Supplement to establish their own perspective on this evolving matter.

Michael L.J. Apuzzo

Pharmacological Therapy after Acute Cervical Spinal Cord Injury

“Treatment with methylprednisolone for either 24 or 48 hours is recommended as an option... that should be undertaken only with the knowledge that the evidence suggesting harmful side effects is more consistent than any suggestion of clinical benefit.”



American Association of Neurological Surgeons &
Congress of Neurological Surgeons
- March 2002

Guidelines for the Management of Acute Cervical Spine and Spinal Cord Injuries: 2013 Update

Beverly C. Walters, MD, MSc, FRCSC, Mark N. Hadley, MD, R. John Hurlbert, MD, PhD, FRCSC, Bizhan Aarabi, MD, FRCSC, Sanjay S. Dhall, MD, Daniel E. Gelb, MD, Mark R. Harrigan, MD, Curtis J. Rozelle, MD, Timothy C. Ryken, MD, MS, and Nicholas Theodore, MD

- “Administration of methylprednisolone for the treatment of acute SCI is not recommended. Clinicians considering methylprednisolone therapy should bear in mind that the drug is not approved by the Food and Drug Administration for this application. There is no Class I or Class II medical evidence supporting the clinical benefit of methylprednisolone in the treatment of acute SCI. Scattered reports of Class III evidence claim inconsistent effects likely related to random chance or selection bias. However, Class I, II, and III evidence exists that high-dose steroids are associated with harmful side effects, including death.”

Surgery is Recommended

- Recommended for patients in cases of spinal instability, neurological deterioration, and severe spinal stenosis to remove degenerative pathology and enlarge the spinal canal as well as fixate instability
- Bose et al 1984 found patients treated surgically had significantly higher ASIA motor scores at discharge than those treated conservatively
- Chen et al 1997 and 1998 demonstrated surgical patients had more rapid and complete return of neurological function, especially in upper extremities, than patients treated non surgically

Controversy on Timing of Surgery

- Several notable studies and surgical spine specialists over the past 60 years have recommended delaying surgery for central cord syndrome
- Goal to wait for a clinical plateau in spontaneous neurological recovery
- Schneider et al 1954 warned that early surgical decompression was contraindicated, because spontaneous improvement or complete recovery could occur, and because surgical decompression of the fragile spinal cord could cause neurological worsening

Rodent Models on Timing

- Rodent SCI models demonstrate there is an association between both duration and severity of compression with neurological deficit
- Secondary injury due to ischemia, neurotransmitter and electrolyte derangements, lipid peroxidation, causing inflammatory cascade
- Ziu et al 2014 demonstrated prolonged spinal cord compression leads to altered micro-RNA expression, and thus secondary injury may not just be due to acute cytotoxicity, but active changes in protein synthesis

In the Real World

- No class I studies that have examined safety or neurological outcomes in patients who undergo early versus delayed surgical decompression for central cord syndrome
- Results of multiple studies and systematic reviews of the literature, including Anderson et al 2015, Lenehan et al 2010, Fehlings et al 2006 indicate that patients operated on <24 hours after injury exhibit significantly greater improvements in total ASIA motor score at 6 months and 1 year than patients operated on >24 hours

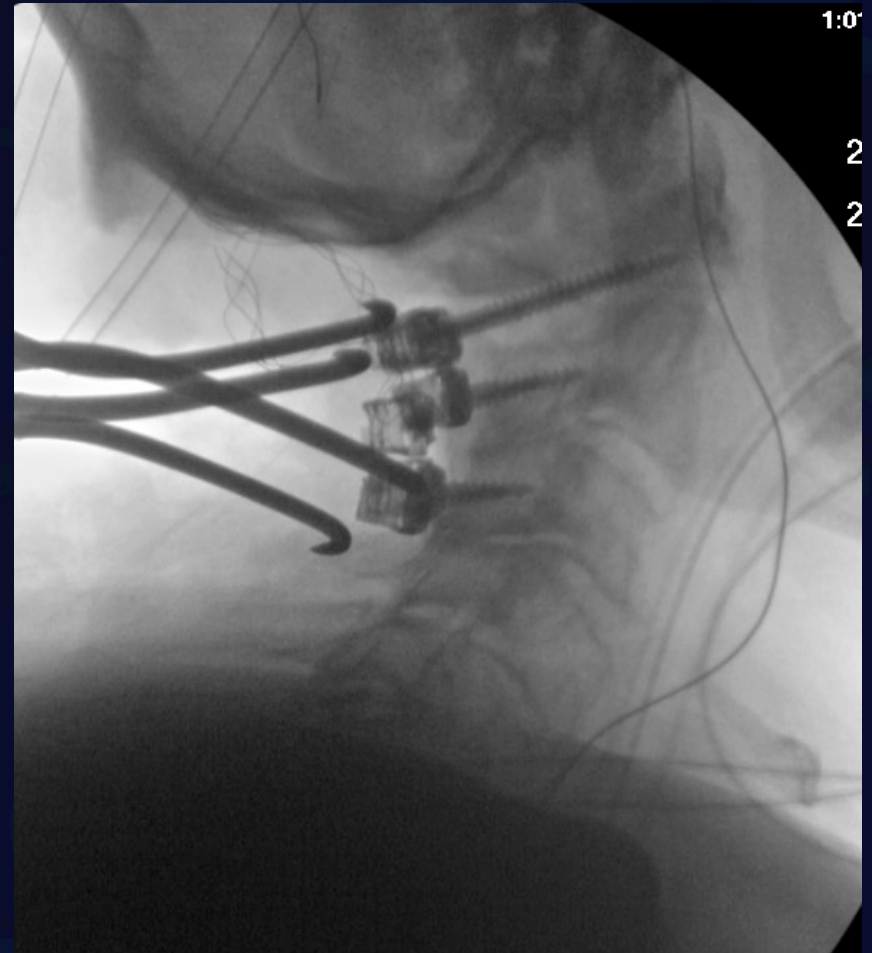
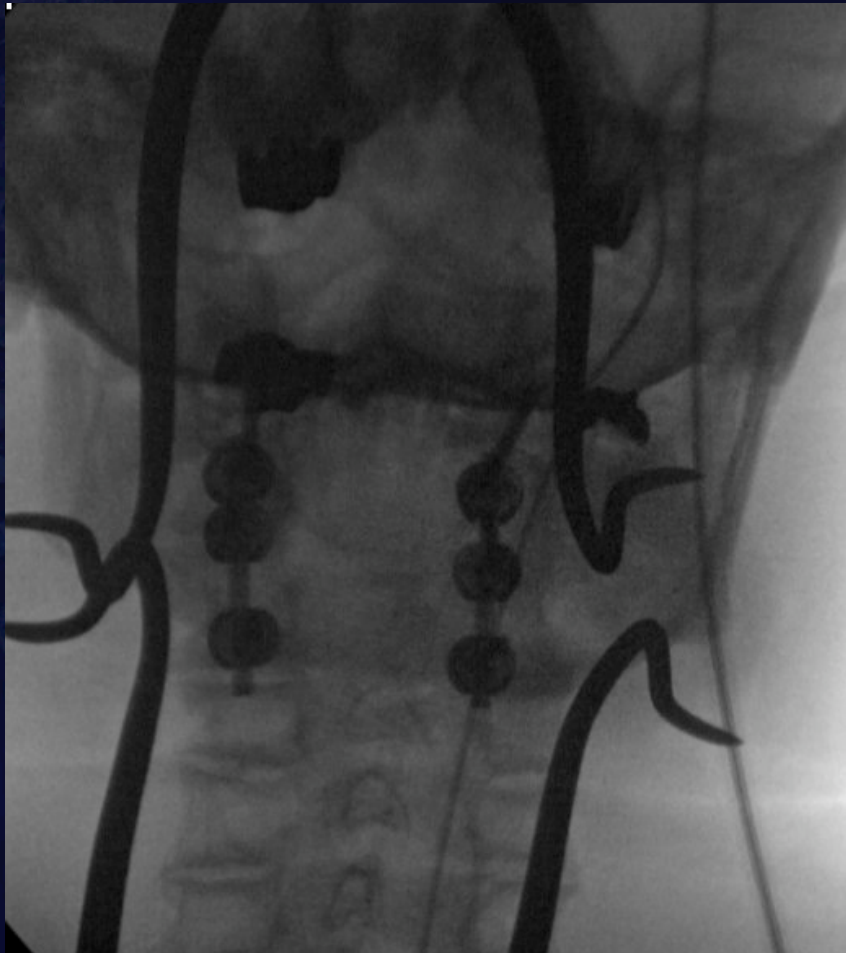
Timing of Surgery

- Good amount of data comes from the STASCIS trial (Surgical Timing in Acute Spinal Cord Injury Study) as some of the best quality data on this topic
 - Multicenter, international, prospective cohort study in adults aged 16-80 with cervical SCI from ages 16-80
- Fehlings et al 2006 noted that early (<72 hours) surgical decompression is safe in the hemodynamically stable patient, and that surgical decompression <24 hours may result in reduced medical complications after acute SCI

Timing of Surgery: the BNI experience

- Guest and Sonntag et al 2002 evaluated 50 patients with central cord syndrome who received early surgery (<24 hrs after injury) or late surgery (>24 hrs after injury)
- Early surgery was associated with shorter ICU stay and length of hospital stay
- Patients with central cord syndrome due to acute disc herniation or fracture/dislocation who underwent early surgery had significantly greater overall motor improvement
- Those with central cord syndrome due to spinal stenosis or spondylosis did not have a significantly different motor outcome

Case JC



Transition to Rehab

- Recovery needs an interdisciplinary approach
- Occupational therapy management focused on improving hand/finger coordination and control, feeding, dressing, and brushing teeth
- Physical therapy for help with transfers, sitting balance, standing balance and eventual walking
- Speech therapy for swallowing dysfunction

Further Rehab Care

- Orthostasis management by implementing the abdominal binder and compression stockings
- Wound and infection prevention activities
- Medication adherence
- Monitoring of nutrient intake
- Training for bowel and bladder incontinence so that patient can be self-sufficient

Conclusions

- Central cord syndrome is the most common incomplete spinal cord injury
- Have high clinical suspicion after hyperextension injuries in elderly with decreased function in upper extremities
- MRI most helpful imaging study
- Acute care mainstays include appropriate maintenance of spinal cord perfusion as well as surgical decompression
- Rehabilitation requires an interdisciplinary approach

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