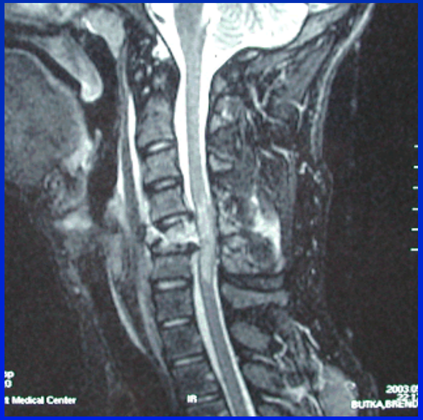
Sports Related Cervical Spine Injuries: Initial On the Field Management



Steven C. Ludwig, MD
Professor and Chief of Spine Surgery UMMS
Fellowship Program Director
Department of Orthopaedics

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18 year old Annapolis High School Football Player

- Strong safety sustaining massive hit
- Semiconcious, difficulty moving arms and legs, neck pain

What do I do now?

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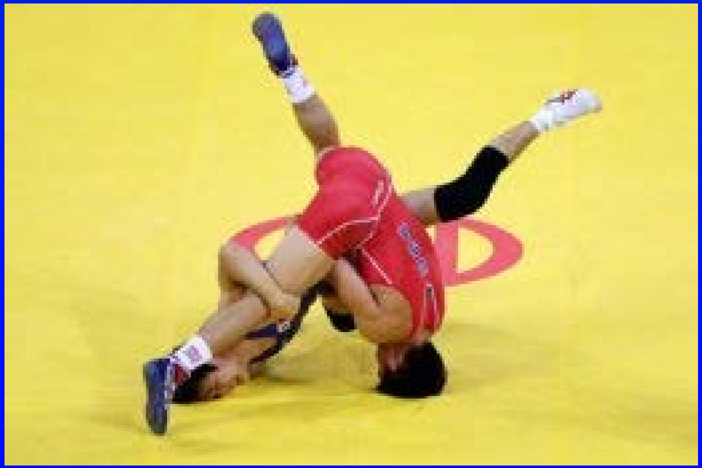
Introduction

- Initial evaluation is complex process
- Critically important to be thorough and accurate
- High index of suspicion
- Goal: Make the diagnosis!



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On-the-Field Management

- Daunting task
- Visibility
- Uncomfortable environment
- Most injuries are minor

On-the-Field Management

- Preparation
- Suspicion/Diagnosis
- Stabilization/Safety
- Implementation of Treatment
- Return to Play

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Preparation

- Proper Training
- Practice in simulated environments
- Emergency plan/ambulance on standby for high impact events
- Necessary equipment available
- Transport equipment available and tested prior to event

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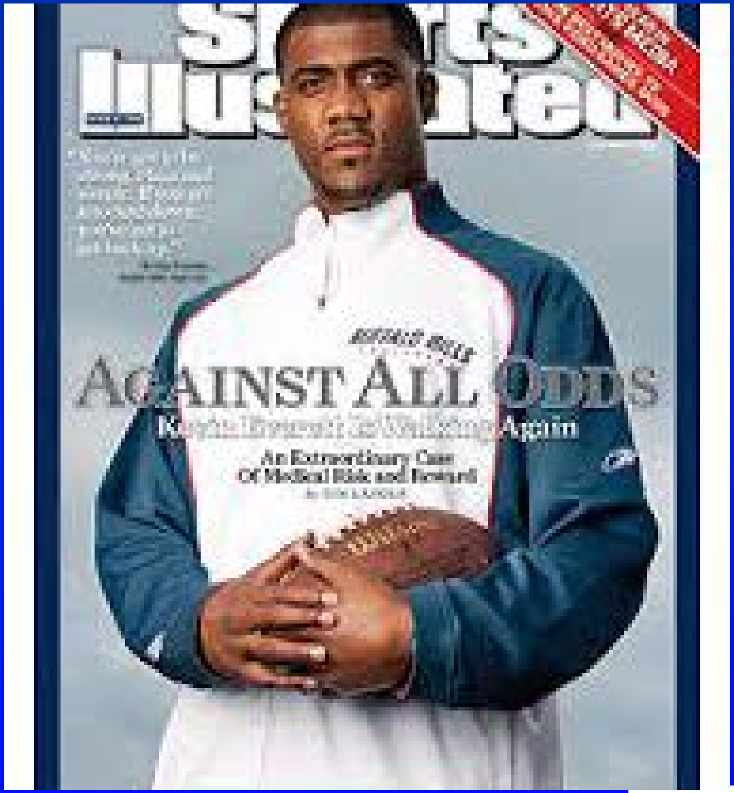
Sports Related Spine Injuries

- Football most common sport
- Cervical Strain
- Stingers and Burners
- Cervical Cord Neuropraxia
- Traumatic Disc Herniation
- Cervical Fracture



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Cervical Sprain

- "Jammed neck" from collision
- Symptoms:
  - Axial pain only; no radicular symptoms
- Signs:
  - ↓ ROM
  - ± Focal tenderness
  - Normal neurological exam

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Cervical Sprain

- Return-to-play:
  - No significant focal tenderness
  - Full ROM
- Further evaluation:
  - Residual localized pain
  - ↓ ROM
  - Prognosis good c-spine radiographs
  - 1-2 weeks Return to Play

Root/Brachial Plexus Neurapraxia

- "Stinger" ("Burner")
- Most common spine injury in football
- Compression or traction injury to root(s) or brachial plexus
  - Compression: plexus compressed between shoulder pad and superior medial scapula by shoulder pad
  - Traction: upper trunk tensioned by shoulder depression, lateral head flexion to opposite side and head flexion to same side
  - Hyperextension: Nerve root compresion within neural foramina

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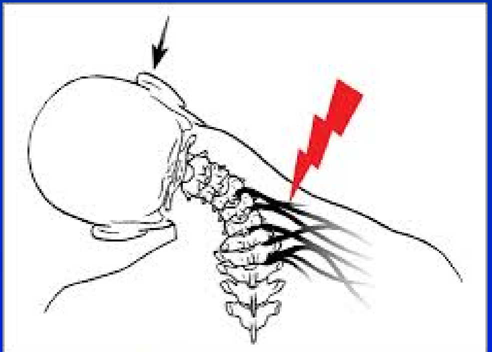
Root/Brachial Plexus Neurapraxia

- Symptoms:
  - *Unilateral*, transient "dead arm"
  - Burning pain
  - Transient weakness



One mechanism of a burner where the nerves (brachial plexus) are stretched.

- Signs:
  - Transient weakness in upper trunk innervated muscles
    - Deltoid, biceps, supraspinatus, infraspinatus

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Root/Brachial Plexus Neurapraxia

Evaluation and Return-to-play

- Full neurological exam
  - If normal→return-to-play
  - If abnormal→further evaluation
- If 2nd event: withhold
- Proper equipment
  - Thick neck roll
  - Total contact neck-shoulder-chest orthosis

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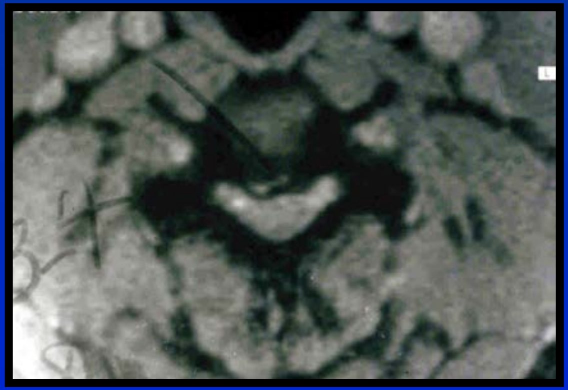
Cervical Disc Injury

- Axial loading impact
- Most common at C3-4 and C4-5
- Defensive Backs and Lineman most common
- Present with Neck pain and Radicular Sx
- May have Motor and Sensory deficits/SCI
- Tx: supportive to operative



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Football Milestones

1869 Princeton vs. Rutgers (first game)

1896 Introduction of football helmet

1905 President Roosevelt condemned brutality of football

1906 Rules changes to eliminate roughness and to reduce danger

1940's Plastic helmet introduced (late 1940's)

1950's Single-bar face mask introduced (early 1950's)

1969 National Operating Committee on Standards for Athletic Equipment (NOCSAE) founded

1971 National Football Head and Neck Injury Registry (Torg)

1976 Rules changes outlawing "spearing"

1978 NOCSAE safety standards for college football helmet (1980-H.S.)

1975-94 Reduction in catastrophic head and neck injuries

Head & Neck Injuries Rate: 1959-1963 vs 1971-1975

(Injury Rates per 100,000)

Source (year)	Intracr. Hemorr.	Intracr. Death	C-spine Fx/Dislc.	Cervical Quad.
Schneider (1959-63)	3.39	1.58	1.36	0.73
NHNIR-Torg (1971-75)	1.15	0.92	4.14	1.58

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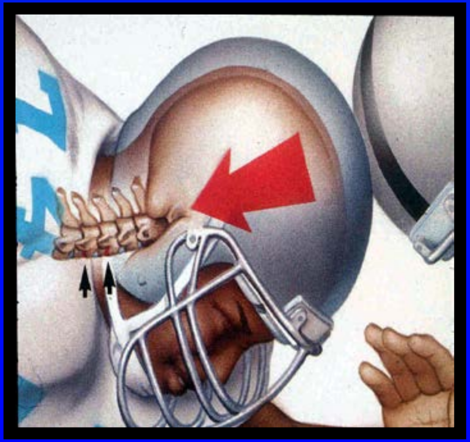
Head & Neck Injuries Rate :1959-1963 vs 1971-1975

- 66% ↓ in Intracranial Bleeds
- 42% ↓ in Craniocerebral Deaths
- 204% ↑ in C-spine Fx / Dislocations

Head & Neck Injuries Rate :1959-1963 vs 1971-1975

- Conclusion
  - Modern helmet: protected head, but *promoted* playing techniques (e.g. "spearing") which placed cervical spine at risk

Headfirst technique → Axial loading



Spearing: Injury Mechanism

- Axial load to straightened spine ("spearing")
  - 52% of permanent quadriplegia football injuries from 1971-75 attributed to *spearing*

Torg, et.al.
JAMA - 1979

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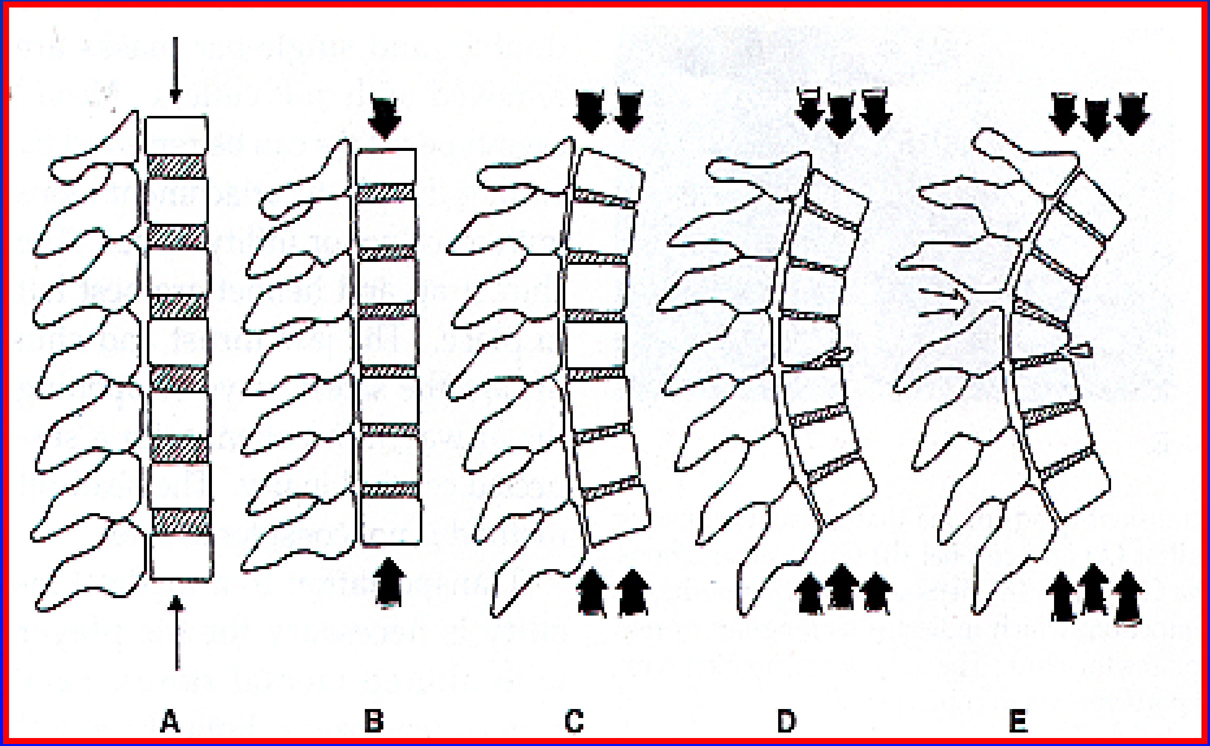
Spearing

↑ Axial load

Compressive deformation

Angular deformation

Failure in flexion



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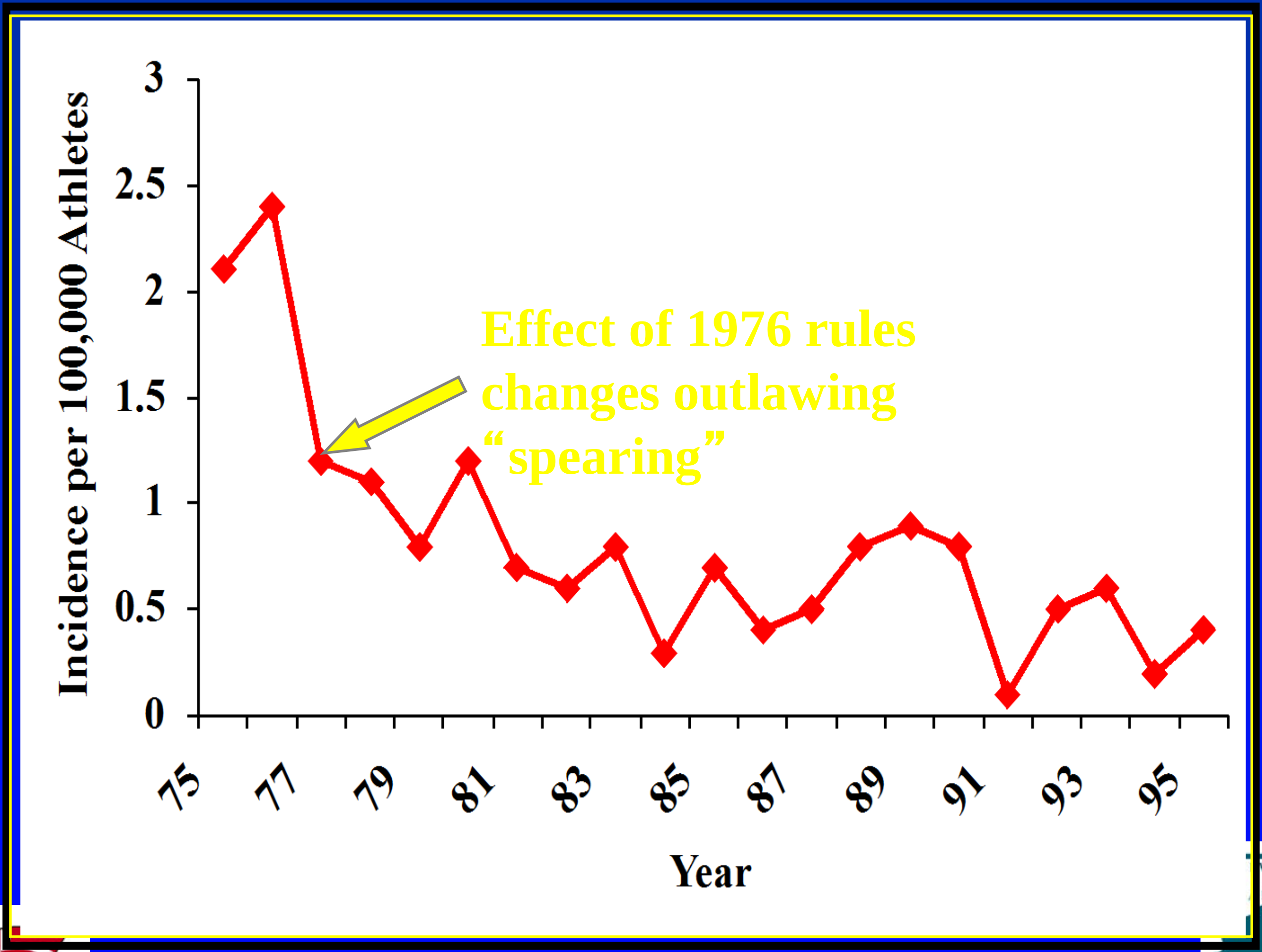
Proper Technique

- Keep head *up* to maintain cervical lordosis
- Avoid hitting with crown of head

Quadriplegia in H.S. & College Football Athletes



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Cervical Cord Neurapraxia (CCN)

Sensory Changes

- Burning pain
- Numbness
- Tingling
- Loss of sensation

Motor Changes

- Paresis
- Paraylsis
- UE &/or LE

Torg, et.al.

JBJS (68-A) - 1986

Cervical Cord Neurapraxia (CCN)

- 1984 football season
- 344 of 503 (68%) NCAA schools responding
- 39,377 players

- Group I
  - Transient quadriplegia with paresthesia
  - Incidence: 1.3 per 10,000
- Group II
  - Transient paresthesia only (UE &/or LE)
  - Incidence: 6 per 10,000

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Incidence: 7.3 per 10,000

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Cervical Cord Neurapraxia (CCN)

- 24 athletes with cervical cord neurapraxia (CCN):
  - Developmental Stenosis: 12
  - Instability / disc disease: 8
  - Congenital anomalies: 5

Cervical Cord Neurapraxia (CCN)

- Conclusion: Cervical neurapraxia does NOT predispose to permanent neurological injury
- Caveat: Avoid contact sports for athletes with cervical neurapraxia plus:
  - cervical instability
  - Acute / chronic degenerative change

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Cervical Cord Neuropraxia

- Occurrence of transient cervical neurapraxia and SCI are unrelated
- No association *per se* between developmental narrowing of canal and quadriplegia
- Developmental narrowing *in the absence of instability* does not predispose to permanent injury
- Major factor predisposing to quadriplegia is <u>spearing and head-impact techniques of tackling</u>

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Etiology of SCI

1. Motor Vehicle Accidents (47.5%)
2. Falls (22.9%)
3. Violence (13.8%)
   - primarily firearms.
4. Sports Related Injuries ↓ (8.9%)
   - Football and then diving injuries most common.
5. Other (6.8%)

Facts & Figures at a Glance (June 2005),
National SCI Statistical Center

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Epidemiology of SCI

- Incidence: 40 cases per million, ~11,000 injuries / yr in the U.S.
- Prevalence: ~ 250,000 persons in U.S. living w/ SCI
- Gender: 80% male (4:1 male-to-female)
- Mean Age: 37.6 years since 2000
  - up from 28.7 (1973 - 1979)
- Tetraplegia to Paraplegia: ~50:50

Facts & Figures at a Glance (June 2005),

National SCI Statistical Center

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Neurologic Status

- 55% SCI Cervical Spine
- 15% SCI Thoracic, TL, LS
- 34% Incomplete Quadraplegia
- 22% Complete Quadraplegia
- 44% Intact

Goals of initial management of spinal cord injury

- Identification of the patient at risk for spinal cord injury
- Prevention of secondary injury
  - Management of hypoxia, hypotension
  - Spinal immobilization

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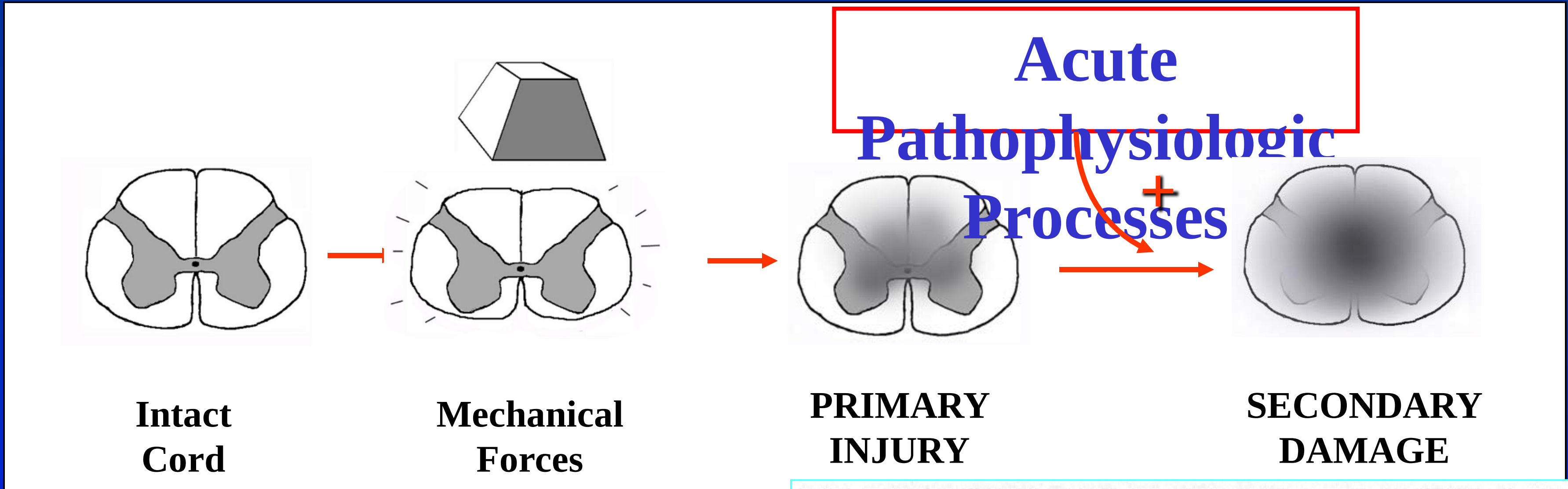
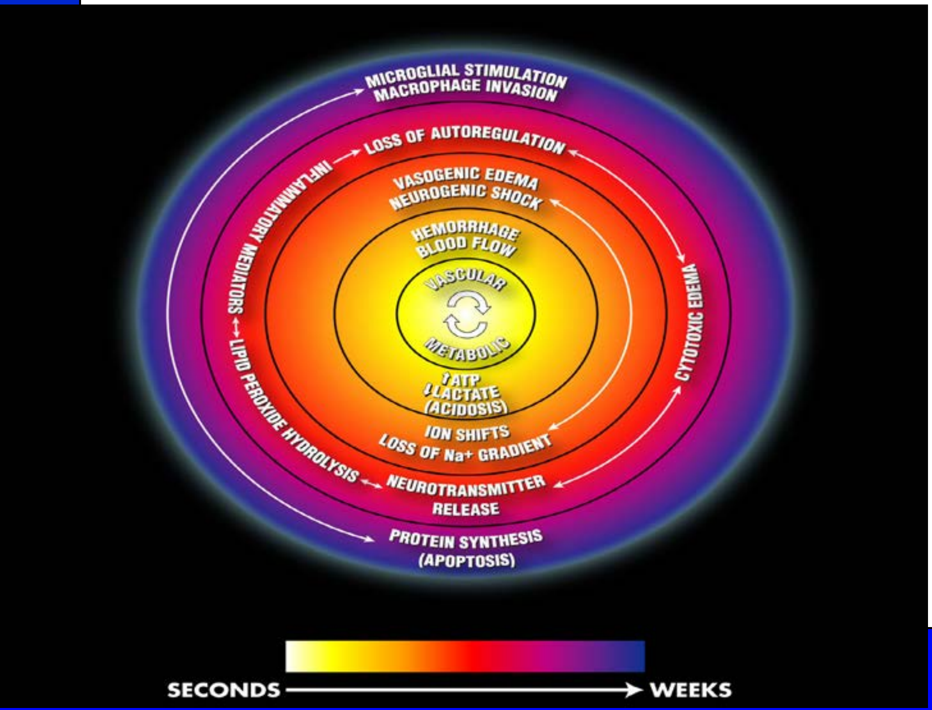
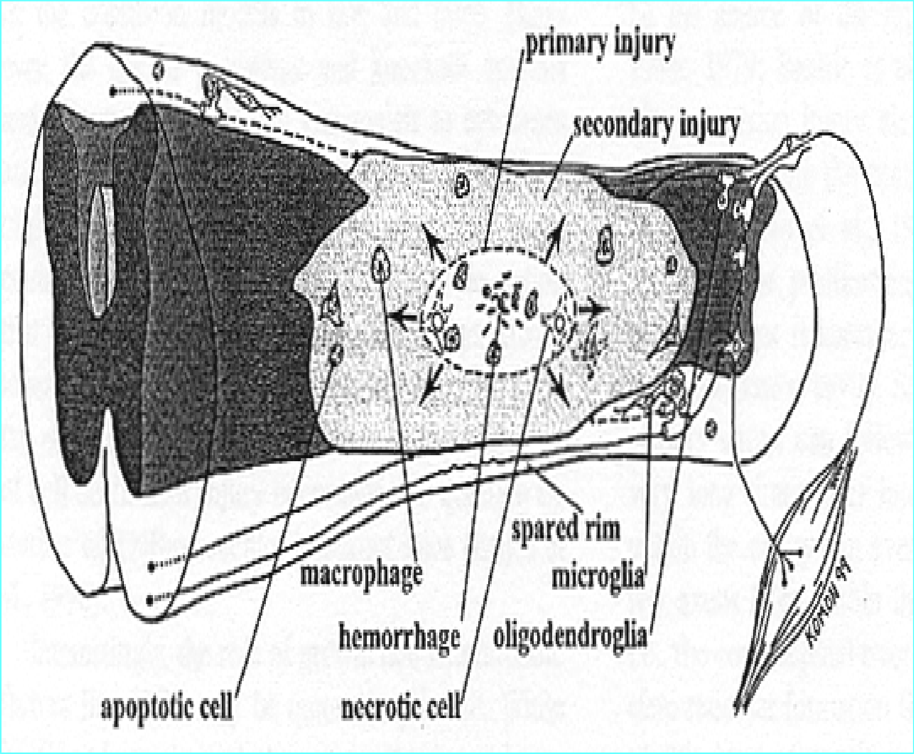
Neuroprotection for Acute Spinal Cord Injury







Who is at risk for cord injury?

- Any patient with <u>significant trauma</u> or any trauma patient with associated <u>alteration in the level of consciousness</u> should be suspected of having a spinal cord injury
  - 5-10% of unconscious patients due to a fall or MVA will have cervical spine injury

Signs of spinal cord injury in an unconscious patient

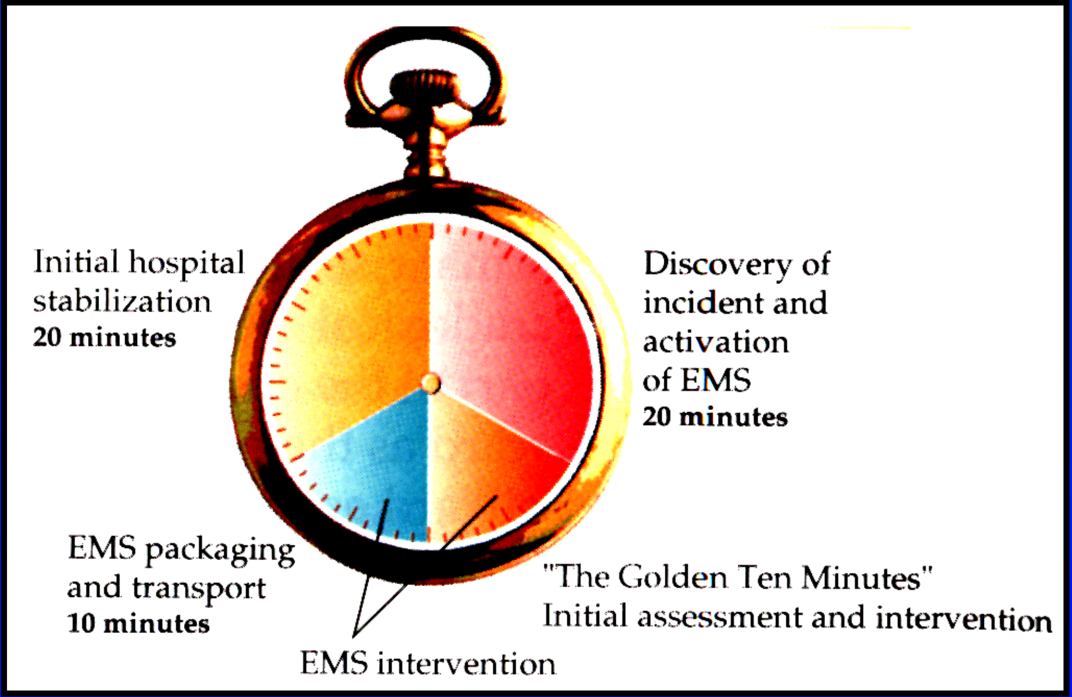
- Flaccid arreflexia
- Diaphragmatic breathing
- Grimaces to pain above, but not below level
- Hypotension and bradycardia without hypovolemia
- Priapism

Field Procedures

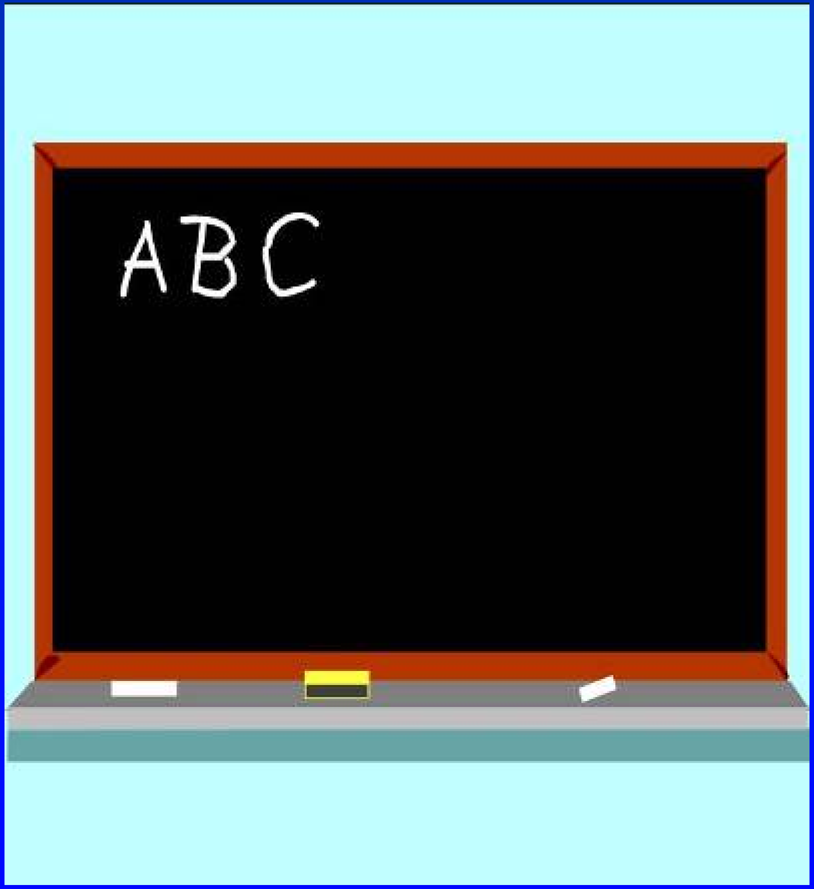
- Secure scene
- Situational assessment
- Primary survey

Pre- Hospital/ Field Assessment

- A-B-C's
- Initial field resuscitation
- C-collar
- Spine board
- **The Golden Hour**



Field Evaluation and Stabilization (ATLS)



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Primary Survery:Airway and breathing issues

- Diaphragm innervated by C3-C5
- Paralysis of intercostal muscles in upper T-cord or higher injuries
- In c-spine injury, prevertebral hematoma or edema may partially obstruct airway
- Pulmonary edema / ARDS
- If intubation needed, endotracheal intubation with no neck movement or blind nasotracheal intubation (LMA)

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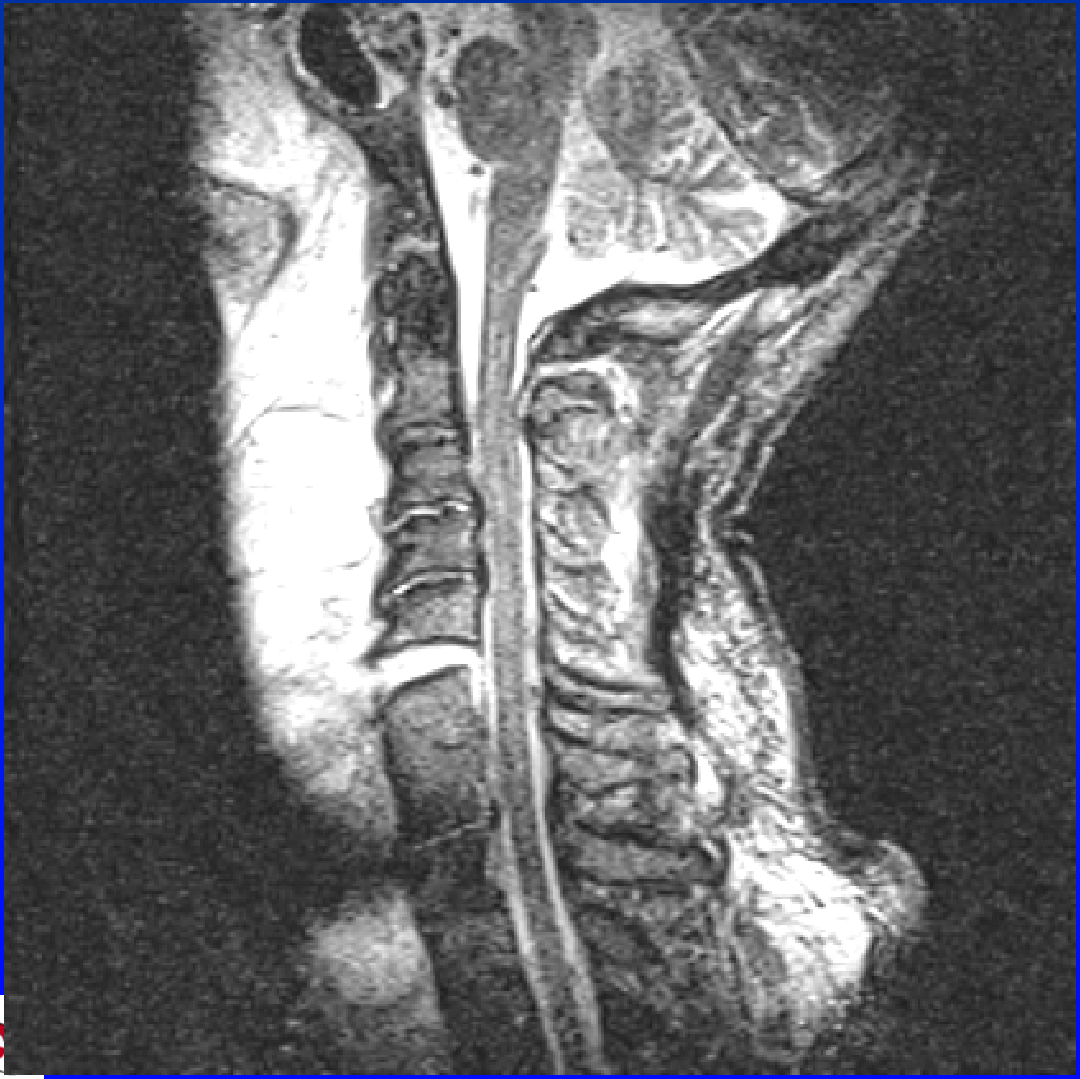
Emergent Airway Access

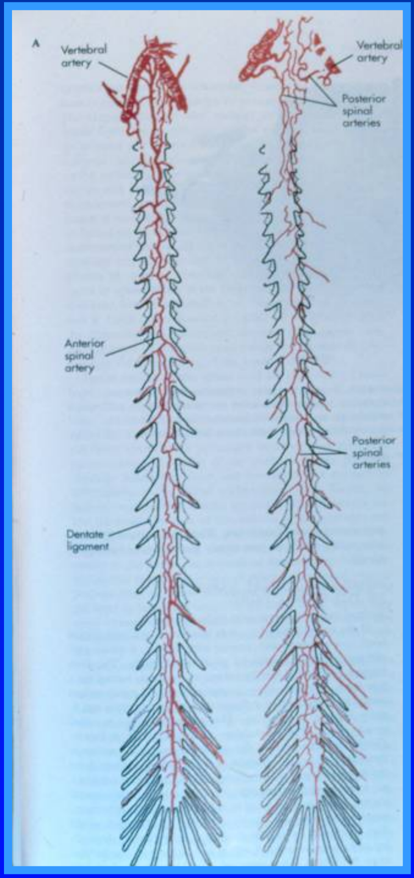
- **DO NOT**
  - head tilt
  - chin lift
- Jaw thrust – oral intubation with manual in-line traction
- Blind naso-tracheal
  - r/o mid-face fxs

Sagittal midline MRI image



Hypotension and SCI

- Vascular Access is mandatory
- SCI pts managed in ICU with aggressive cardiovascular support do better than historical cohort
- Mean blood pressure > 90 mmHg for the first 7 days after acute spinal cord injury is recommended to prevent cord ischemia and prevent secondary insults



Levi et al, Neurosurg 33:1007-16, 1993

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Neurogenic Shock

- Due to impairment of descending SNS pathways (>>> in cord injury above T6)
  - Loss of vasomotor tone leads to vasodilation of visceral and LE vessels, intravascular pooling and hypotension
  - Loss of sympathetic innervation to the heart causes bradycardia

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Hemorhagic Shock

- Massive Blood Loss
- Hypotension with Tachycardia
- Requires fluid rescucitation/inotropic medications
- Can occur with neurogenic shock

Autonomic dysfunction

- Hypothermia:
  - Hypothermia → arrhythmias, coagulopathy, etc.
- Paralytic ileus
  - Need NG (or OG) tube to decompress abdomen
  - Distended abdomen can interfere with respirations
- Urinary retention
  - Foley cath: Prevent bladder overdistension

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Neurological assessment
Secondary Survey

Complete or incomplete injury?

- "Incomplete" = preservation of sensory or motor function below the level of the lesion
- Important to look for:
  - Any voluntary movements in the lower extremities (e.g. voluntary toe flexion)
  - Preserved joint position sense
  - "Sacral sparing" = sensation around the anus, voluntary rectal sphincter contraction

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Motor testing

- Upper extremity
  - C5 – elbow flexors
  - C6 – wrist extensors
  - C7 – elbow extensors
  - C8 – finger flexors (distal phalanx of middle finger)
  - T1 – finger abductors (little finger)
- Lower extremity
  - L2 – hip flexors
  - L3 – knee extensors
  - L4 – ankle dorsiflexors
  - L5 – long toe extensors
  - S1 – ankle plantar flexors

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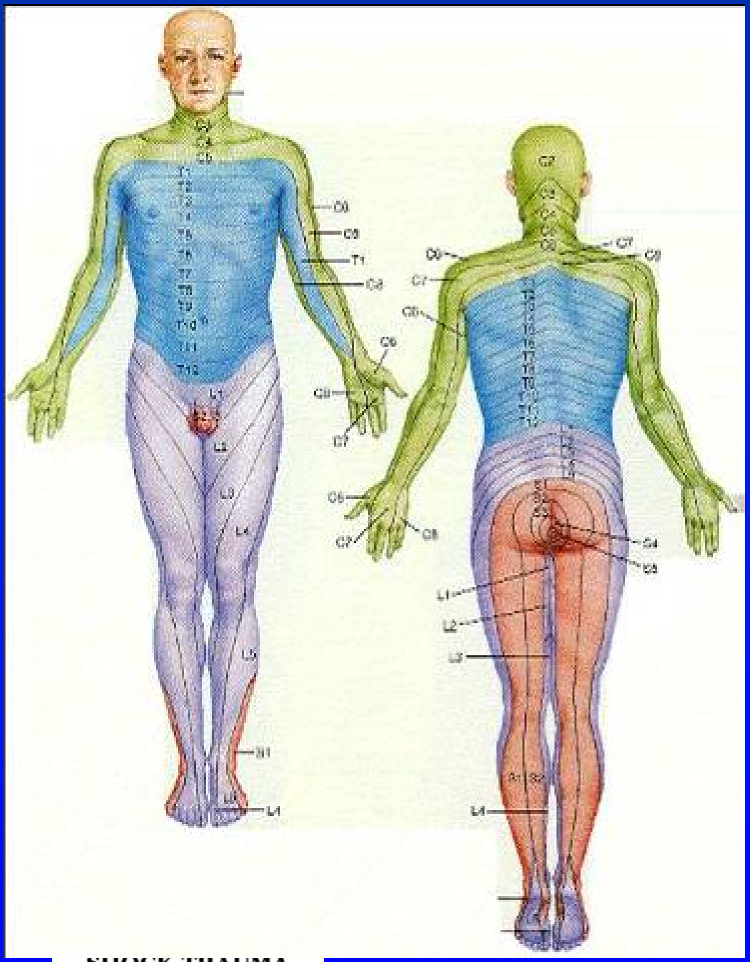
Sensory testing



- C3 – supraclavicular fossa
- C4 – top of shoulder
- C5 – lateral elbow
- C6 – thumb
- C7 – middle finger
- C8 – little finger
- T4 – nipple
- T10 – umbilicus
- L2 – medial thigh
- L3 – medial knee
- L4 – medial ankle
- L5 – dorsum of foot between 1st & 2nd digits
- S1 – lateral heel
- S4-5 – perianal region

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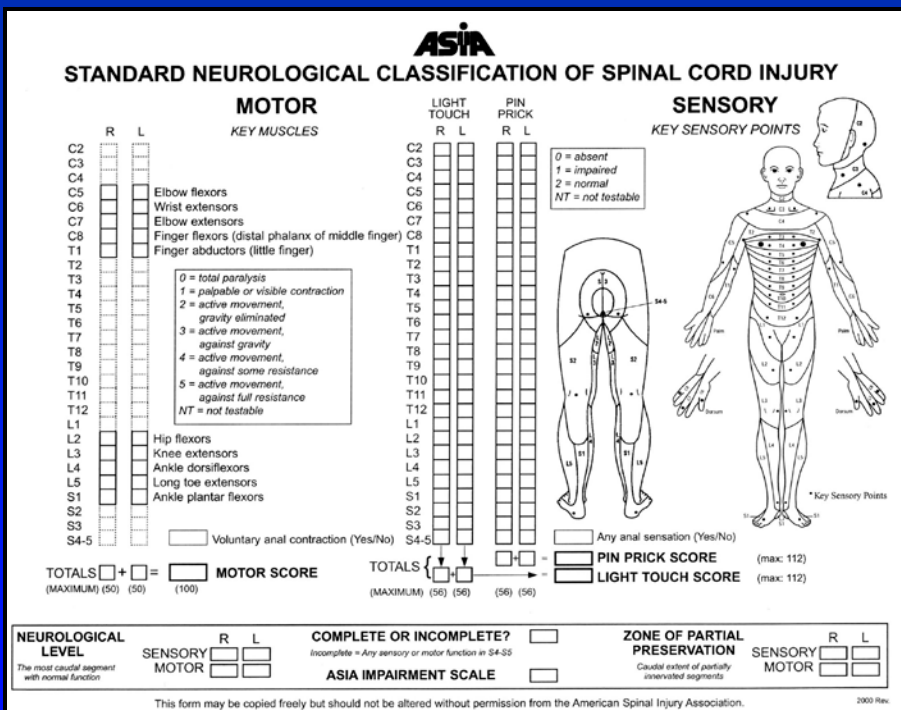
Neurologic Examination



ASIA Motor Index

- A – Complete Lesion
- B – Incomplete - Sensory Only
- C – Incomplete Motor <3
- D – Incomplete Motor >3
- E – Intact

Immobilization

- All trauma patients with spinal column injury, or with a mechanism of injury having the potential to cause spine injury should be immobilized at the scene and during transport
- Recommend rigid with cervical collar and supportive blocks on a backboard with straps
- Prolonged immobilization = decubitous ulcers

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Spine Immobilization

Spine Immobilization

- Extrication – immobilize first
- Goal – neutral alignment
- Rigid backboard – standard
- Supportive Blocks and Straps
- Various patient transfer techniques

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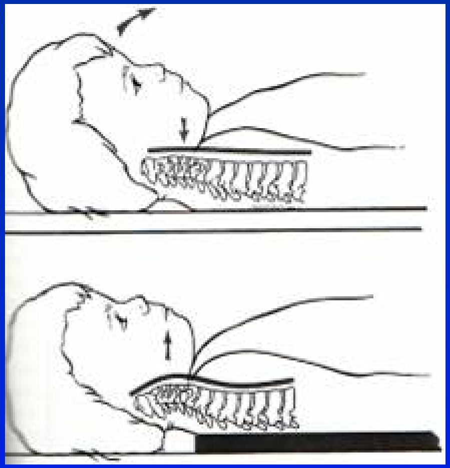
Pediatric Considerations Immobilization

- Immobilize in neutral position
- < age 8: large head :: torso
- *avoid standard spine board*



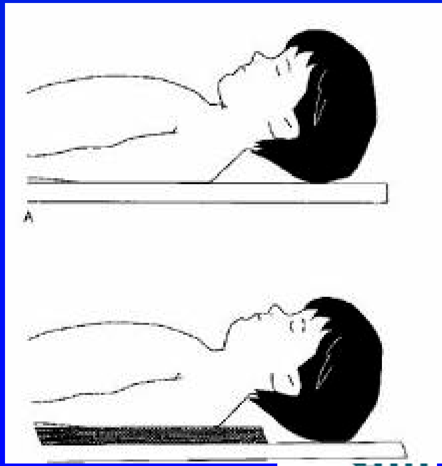
Nyppaver Ann Emerg Med 1994:

Mean torso elevation = 2.5 cm

Align shoulders with external auditory meatus

Huerta Ann Emerg 1987:

- Collar alone not useful
- Recessed board or should roll



**Half spine board, rigid collar & tape !*

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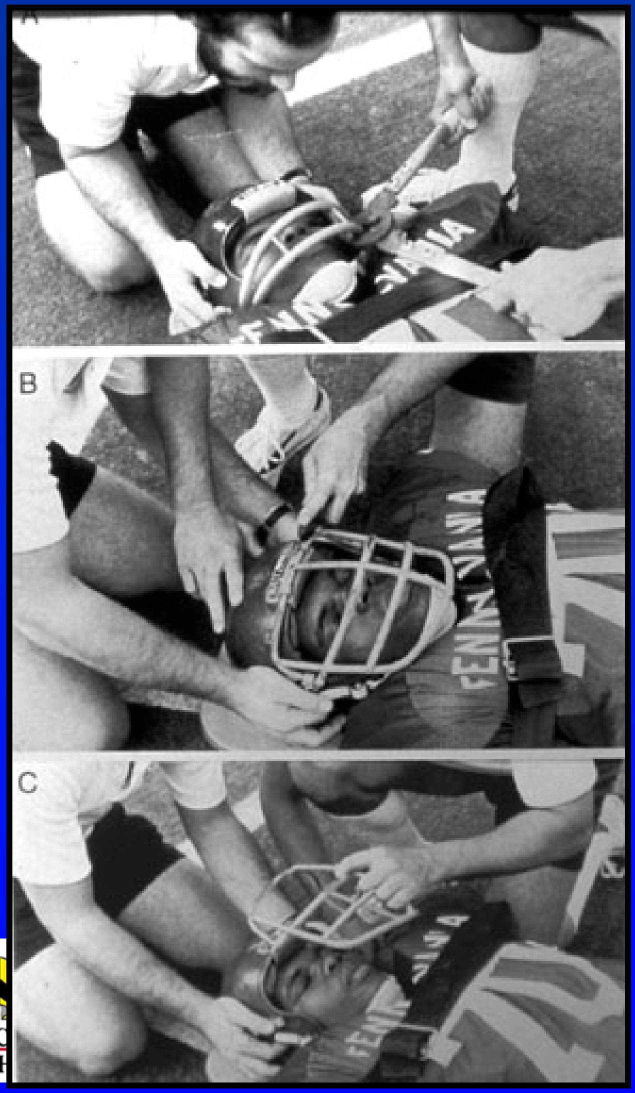
ORTHOPAEDICS

Helmet Removal



Transportation

- Avoid traction
- Supine patient position in Trendelenberg
- Avoid sudden stops and starts
- Tertiary care center if possible

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Transport Priority

- Ambulance < 50 miles (81 km)
- Helicopter 50 – 150 miles (81-242 km)
  peak traffic
  severe injuries
- Fixed wing aircraft > 150 miles (242 km)



Multiple Injured Patient

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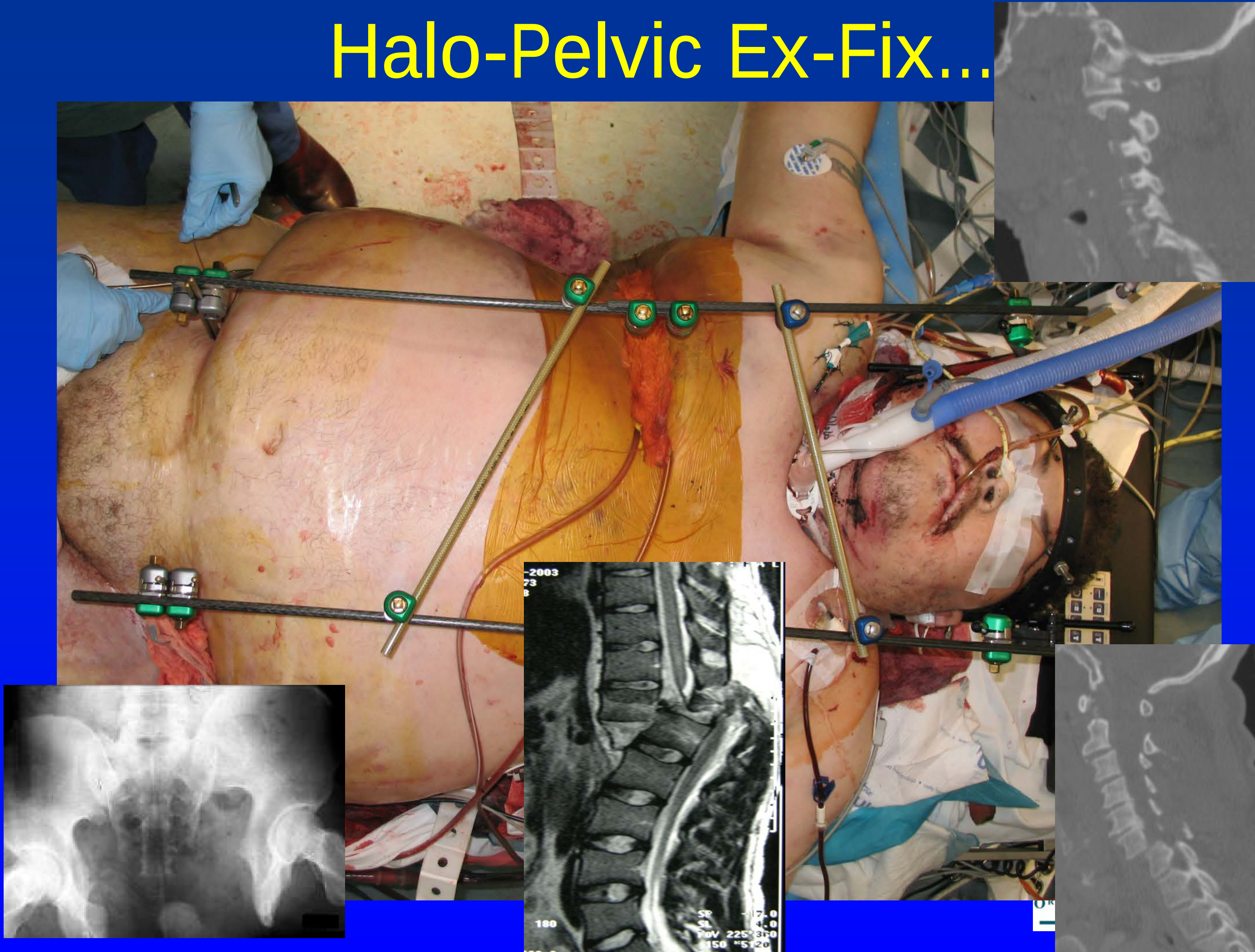
Beware: multiple system trauma

- Trauma associated with spinal cord injury:
  - MSK (18%)
  - Head (16%)
  - Lung (10.5%)
  - Abdominal (2.5%)
  - CV (1.5%)
- The spinal cord injury may mask the presence of other injuries (e. g. abdominal injuries)

Halo-Pelvic Ex-Fix...



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)

The New England Journal of Medicine

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Volume 322 MAY 17, 1990 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)

University of Maryland Orthopaedics

Debating the Merits of Methylprednisolone

J Neurosurg (Spine 1) 93:1–7, 2000

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

R. JOHN HURLBERT, M.D., PH.D., F.R.C.S.(C)

University of Calgary Spine Program, Foothills Hospital and Medical Centre, Calgary, Alberta, Canada

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

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

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]

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

Criticisms of NASCIS 3

Complications Associated with Prolonged MP Infusion

(48 hour infusion vs 24 hour)

Severe pneumonia:	2x	(p=0.02)
Severe sepsis:	4x	(p=0.07)
Death due to respiratory complications:	6x	(p=0.056)

The additional 24 hours of high dose MP infusion is not without additional risk!

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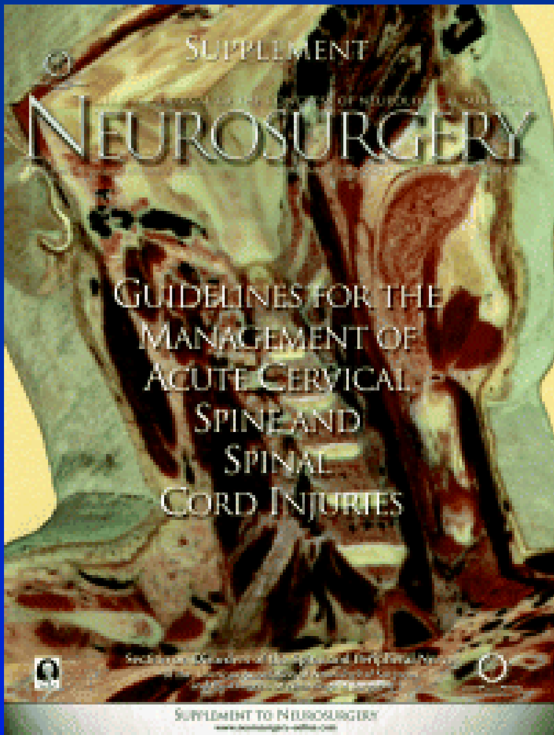

CHAPTER 9

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

American Association of Neurological Surgeons

Congress of Neurological Surgeons 1951 Eruditio Observantia Societas

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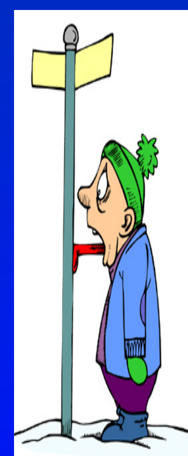
University of Maryland Orthopaedics

Spinal Cord Modest Hypothermia
Potential Benefits

- ↓ volume of damaged tissue
- ↓ # of damaged neurons and axons
- ↓ edema
- ↓ hemorrhage
- ↓ metabolism and energy utilization
- ↓ hypoxic damage
- ↓ decreases blood-brain barrier alterations



- ↓ inflammation (e.g., PMN activity)
- ↓ excitotoxicity
- ↓ free radical production
- ↓ oxidative stress
- ↓ apoptosis
- ↑ functional recovery

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The Use of Systemic Hypothermia for the Treatment of an Acute Cervical Spinal Cord Injury in a Professional Football Player

Andrew Cappuccino, MD,*† Leslie J. Bisson, MD,†‡§ Bud Carpenter, ATC,†
John Marzo, MD,†‡ W. Dalton Dietrich, III, PhD,¶ and Helen Cappuccino, MD||

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CLINICAL STUDIES

Levi et al., Neurosurgery, Feb 23, 2010

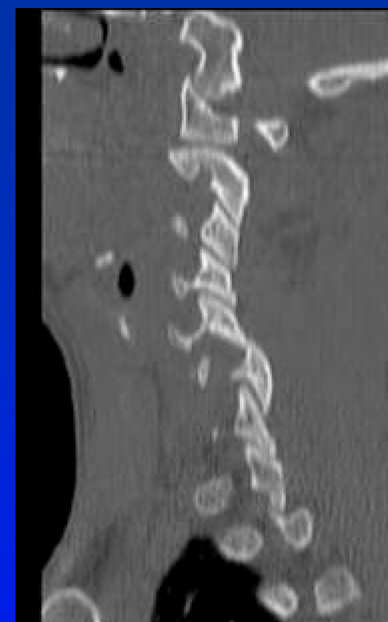
Allan D. Levi, MD, PhD
Department of Neurological Surgery
and the Miami Project to Cure Paralysis,
University of Miami,
Miller School of Medicine,
Miami, Florida

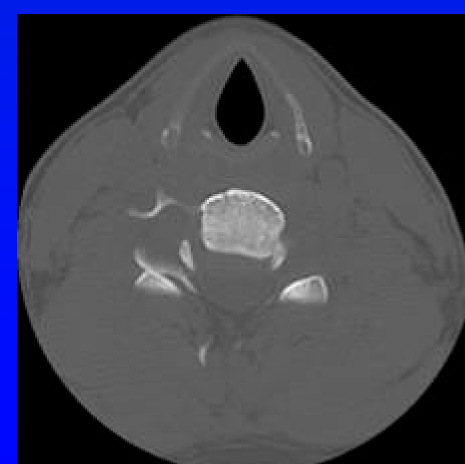
Gizelda Casella, MD, PhD

Clinical Outcomes Using Modest Intravascular Hypothermia After Acute Cervical Spinal Cord Injury

	IMPROVED	SURGICAL DECOMPRESSION <24 HRS
Hypothermia N=14	6	12
Matched Controls N=14	3	7

Radiographic Assessment





Neurological Deterioration Due to Unrecognized Spinal Instability

- Insufficient imaging studies
- Misread imaging
- Poor quality imaging

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Optimal
Radiographic Analysis

- Fast
- Accurate
- Minimize patient transport
- Cost

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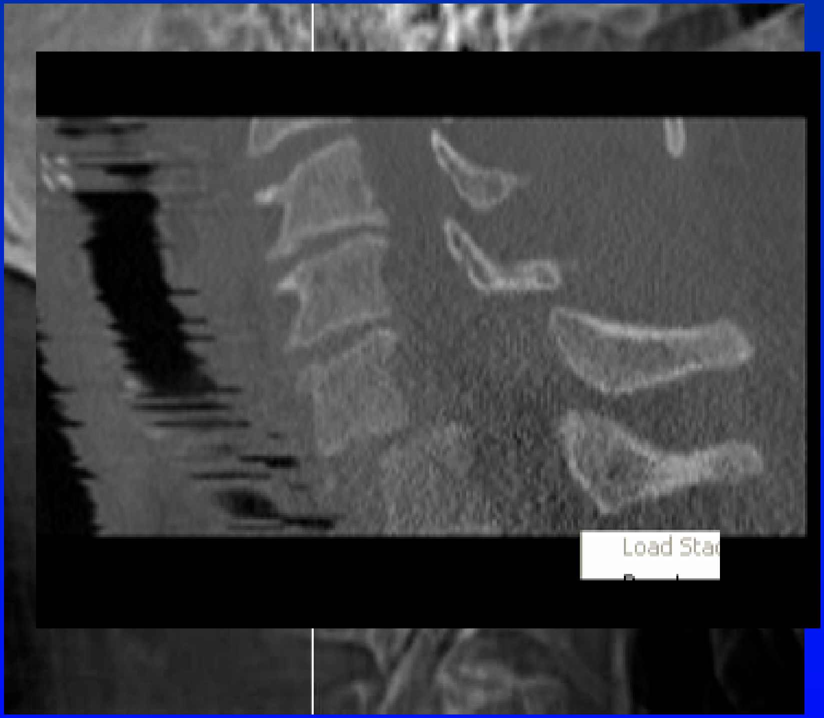
Clinical Clearance of Cervical Spine

- Awake, alert, cooperative
- No drugs, alcohol, loss of conciousness
- Low energy mechanism
- No spinal pain
- No distracting injuries
- No neurological complaints nor deficits

Lateral Cervical Radiograph

- Initial screen frequently inadequate
- Most common reason for missed injuries
- Failure to visualize the cervicothoracic and occipital cervical junction



Davis et al., J Trauma 1993

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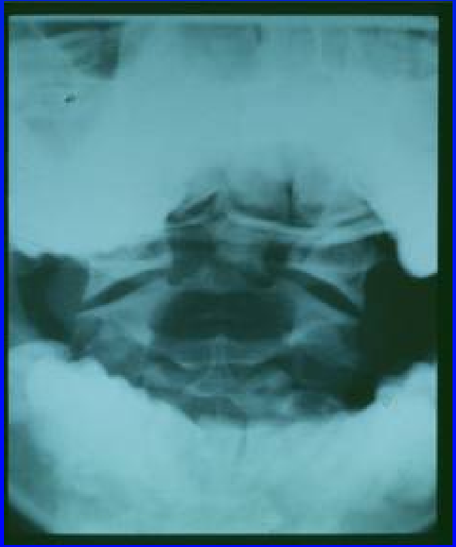
Rationale for Additional Cervical Views

- 74-93% Cervical injuries detected on lateral radiograph
- High false negative rate requires AP/Open mouth view
- 99% Injuries detected on 3 views

Montgomery et al., Neurosurg. 2002



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Indications
Radiographs Thoracic/Lumbar Spine

- Cervical spine injury detected: 11% incidence of noncontiguous spine fractures
- Regional pain
- Chest/Abdomen/Pelvis injuries
- Fall from height with calcaneus fractures
- Neurological deficit at thoracolumbar level
- Altered mental status

Vaccaro et al., J Spinal Disorders 1992

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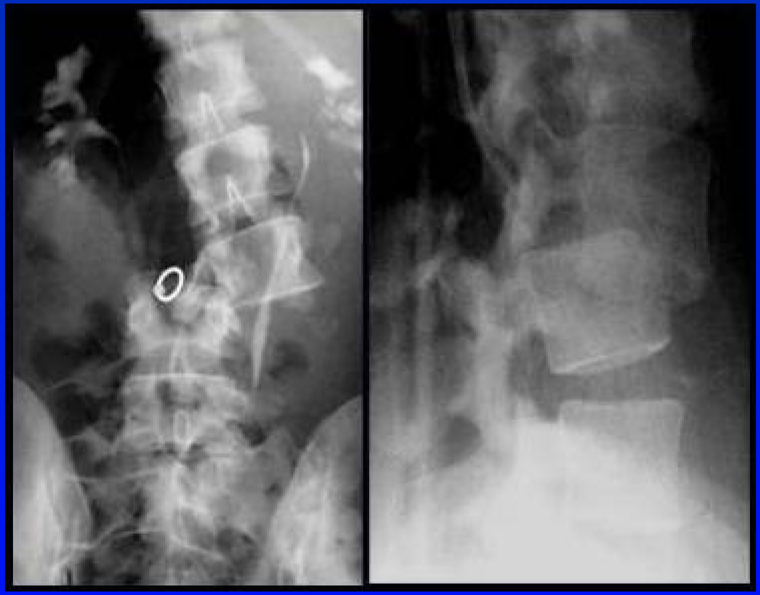
Radiographs
Thoracic and Lumbar Spine

- AP/Lateral Thoracic and lumbar spine
- Difficulties visualizing upper thoracic region
- May cut off thoracolumbar spine
- Flexion-extension views play no role in evaluation of injuries



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Advanced Imaging Studies
CT Scans

- CT integral part of assessing a trauma patient
- Helical CT scanning (Head-toe) <2 minutes: accurate reconstructions
- CT is becoming initial imaging modality of choice for evaluation trauma patients
- CT scan more sensitive then plain radiographs
- Clear visualization of junctions
- Limited ability to detect pure ligamentous injuries

Grogan et al., J Am Coll Surg. 2005
Brandt et al., J of Trauma 2004
Hauser et al., J of Trauma 2003

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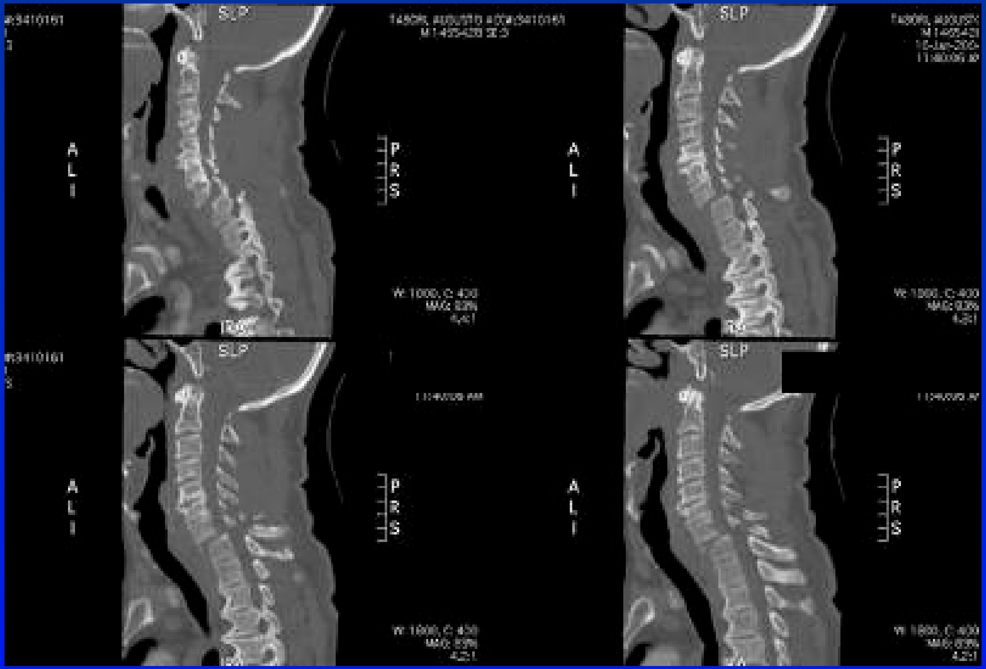
Cervical Spine CT Scan

- Poor quality radiographs
- Detection of cervical injury
- Unable to assess patient
- Neurological injury detected
- Neck pain despite negative radiographs
- Sensitivity/Specificity 98%



McCulloh et al., JBJS 2006

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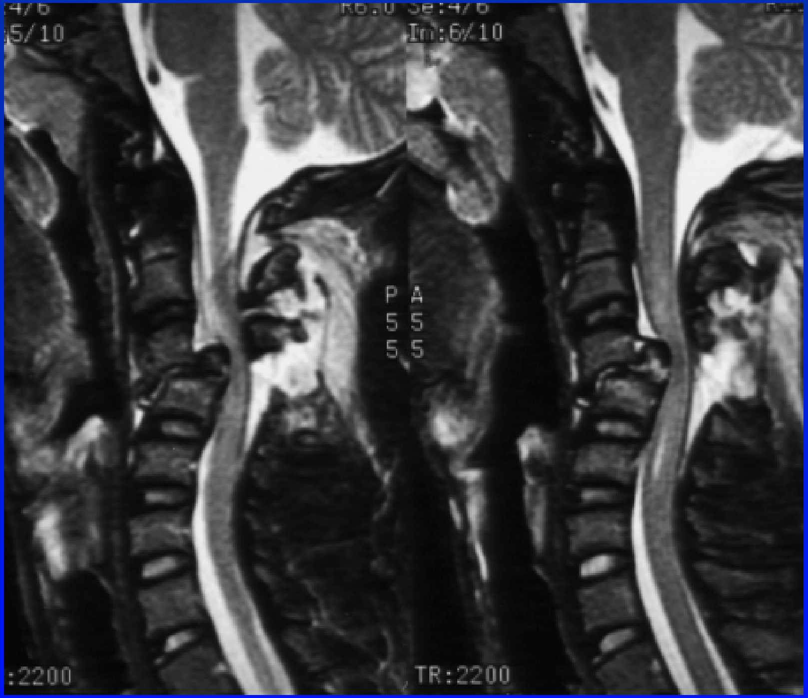
MRI

- Role as initial imaging modality debatable
- Superior visualization of soft tissues: discs, ligaments, spinal cord
- Long acquisition time may be dangerous in hemodynamically unstable patient



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Indications
MRI

- Unexplained neurological deficit based on boney injury
- Suspect HNP in face of cervical dislocation
- SCIWORA- Child, hematoma, herniated disc

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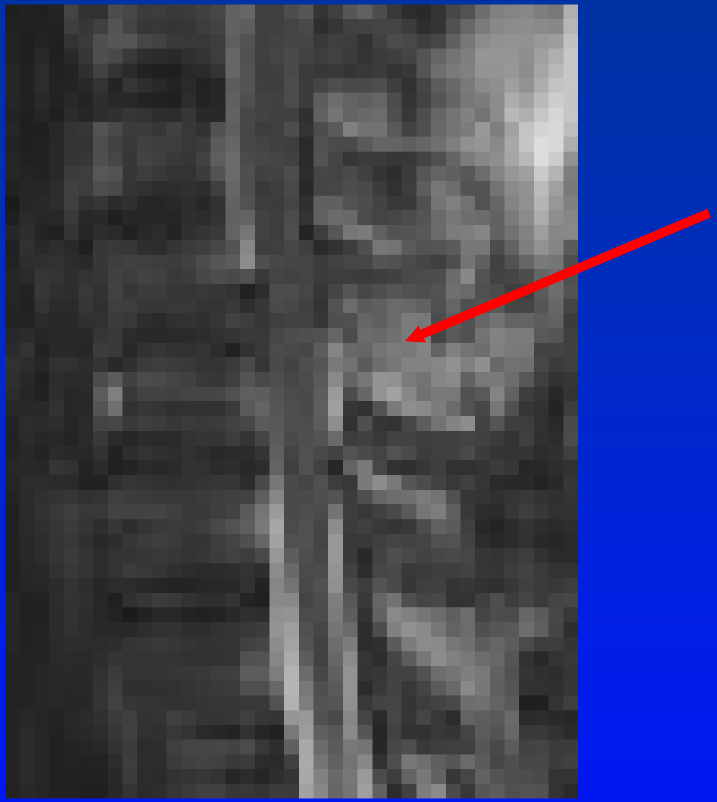
Cervical Spine MRI Uses

- Detection of unstable ligamentous injuries
- Typically a fat suppressed STIR image
- Obtunded patients for C-spine clearance



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18 year old Annapolis High School Football Player

- Strong safety sustaining massive hit
- Semiconcious, difficulty moving arms and legs, neck pain

18 yr old High School football player

- Immobilized
- ABC’s
- EMS mobilized
- IV’s placed, BP maintained, steroid started
- Transported to STC

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18 yr old Male C6
ASIA C

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Conclusion

- Preparedness and organization on the field is mandatory when taking care of athletes
- Always have a high index of suspicion
- Stabilization/Safety always come first
- Understand how to implement acute treatment and appropriate return to play criteria
- SCI are very rare!

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