Cervical Spine Injuries in Athletes

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Disclaimer

- I have no conflicts of interest with regards to this presentation

Outline

- Epidemiology
- On field evaluation & management
- Cervical Sprain/ Strain
- Burners/ Stingers
- HNP and DDD
- CCN / Transient quadriplegia
- Cervical Stenosis
- Fractures
- Spear Tackler's Spine
- Congenital Conditions

Epidemiology – a seldom but catastrophic injury

- Spinal cord injuries are rarely seen on the athletic field
  - 2-3% of all athletic injuries
  - 9% of the 11,000 cases of SCI occurring annually in US are related to athletics
- More than half of catastrophic injuries in sports are cervical spine injuries.
- Most common in:
  - Contact sports: football, hockey, rugby, and wrestling
  - Noncontact sports: skiing, track and field, diving, surfing, power lifting, equestrian events, and cheerleading

Banerjee et al , *AJSM 2004*

Football

- Boden et al (AJSM 2006) retrospectively reviewed incidence of catastrophic cervical injuries in high school and college football

- Incidence of catastrophic events
  - 1.1 per 100,000 in high school
  - 4.72 per 100,000 in college

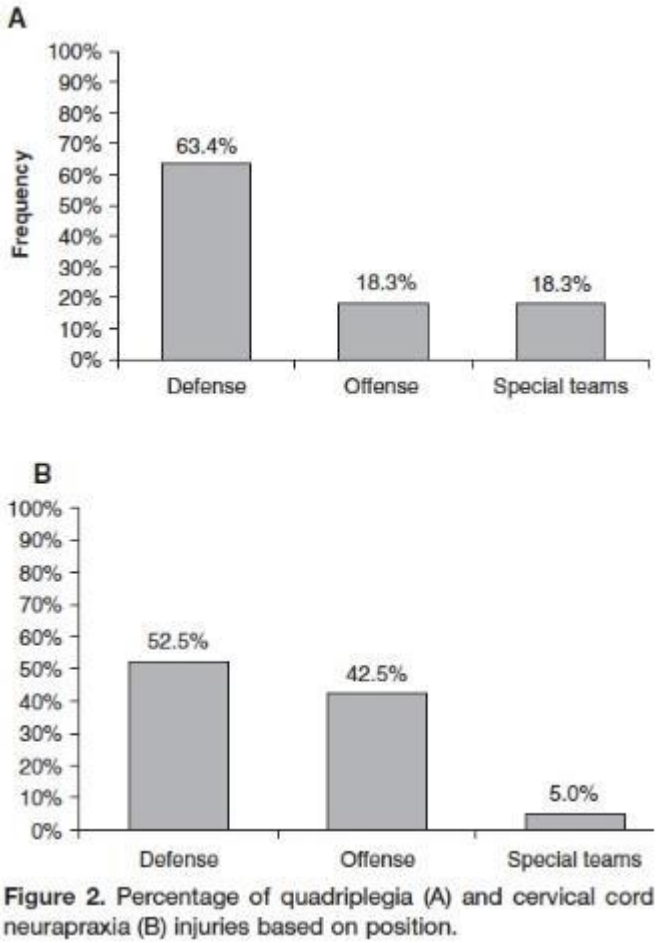
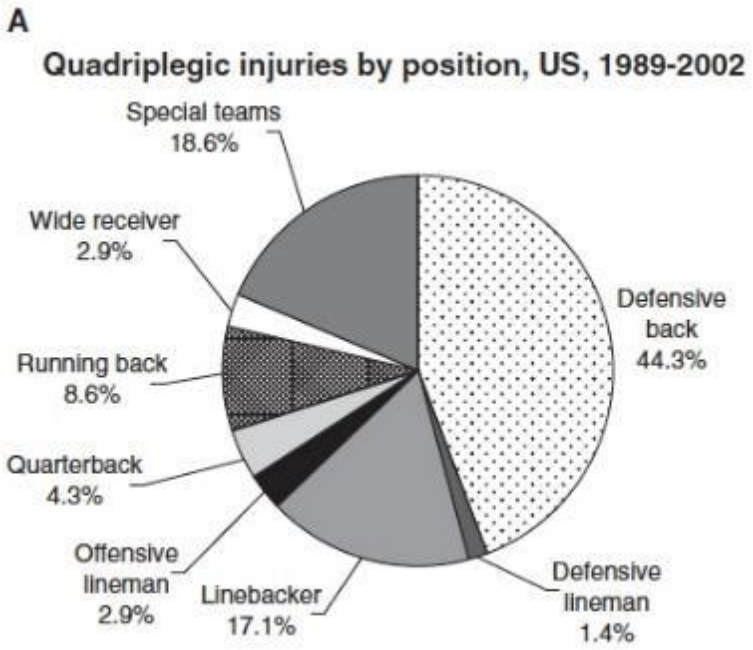


Figure 2. Percentage of quadriplegia (A) and cervical cord neurapraxia (B) injuries based on position.

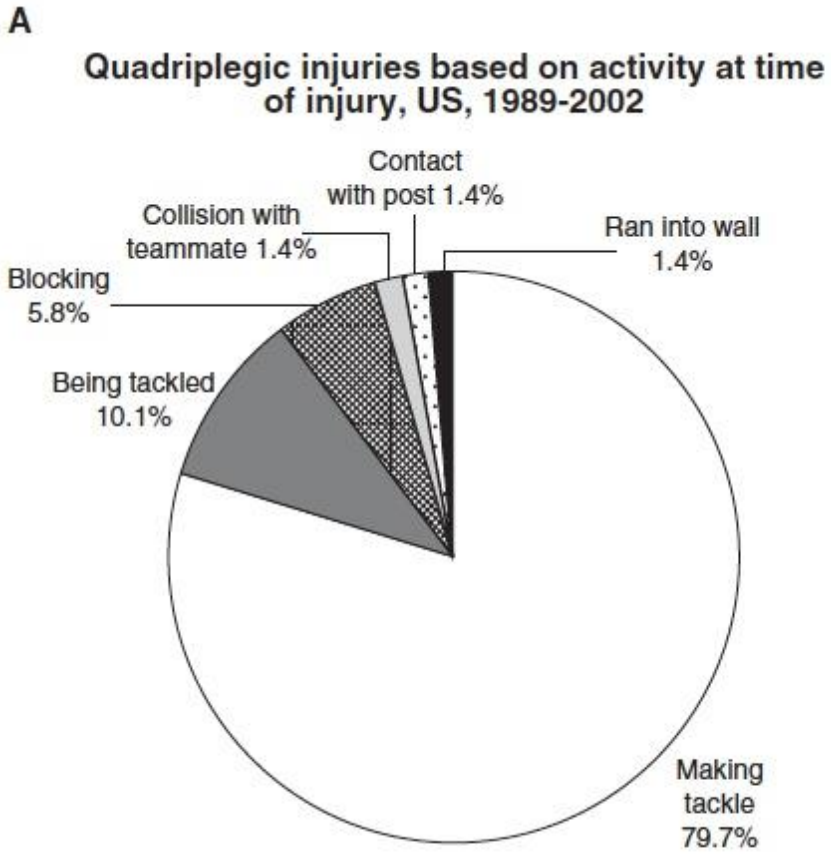
Football


A
Quadriplegic injuries by position, US, 1989-2002
Special teams 18.6%
Wide receiver 2.9%
Running back 8.6%
Quarterback 4.3%
Offensive lineman 2.9%
Linebacker 17.1%
Defensive lineman 1.4%
Defensive back 44.3%

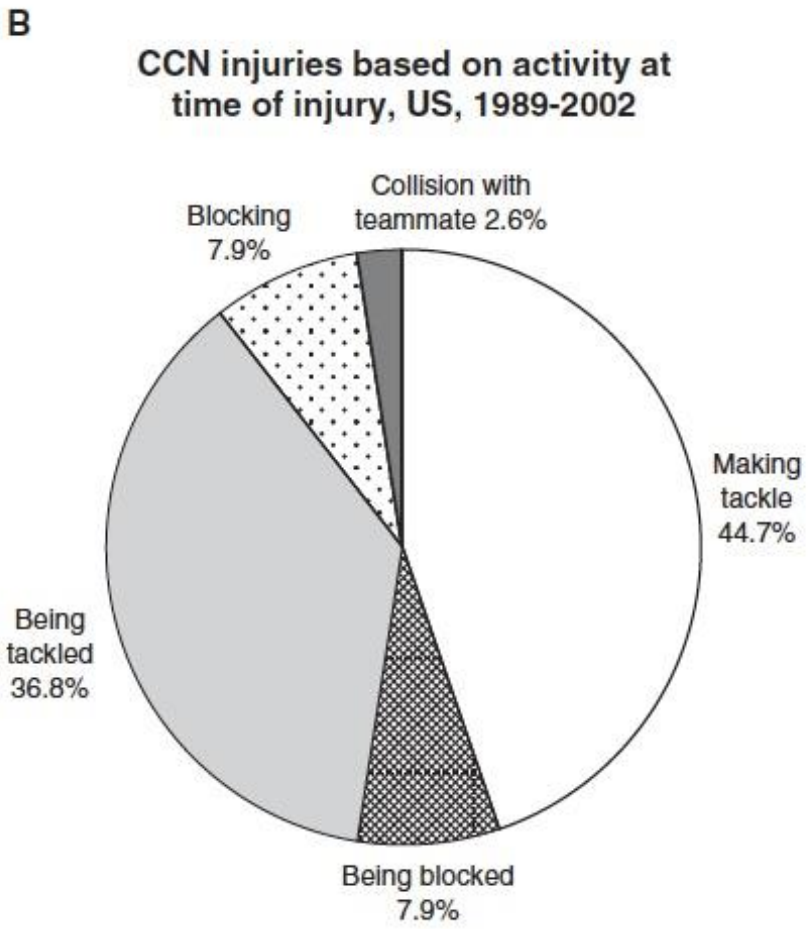

B
CCN injuries by position, US, 1989-2002
Special teams 5.1%
Defensive back 15.4%
Wide receiver 10.3%
Running back 12.8%
Defensive lineman 17.9%
Quarterback 12.8%
Linebacker 15.4%
Offensive lineman 10.3%

Football

A


Quadriplegic injuries based on activity at time of injury, US, 1989-2002
Contact with post 1.4%
Collision with teammate 1.4%
Ran into wall 1.4%
Blocking 5.8%
Being tackled 10.1%
Making tackle 79.7%

B


CCN injuries based on activity at time of injury, US, 1989-2002
Blocking 7.9%
Collision with teammate 2.6%
Making tackle 44.7%
Being tackled 36.8%
Being blocked 7.9%

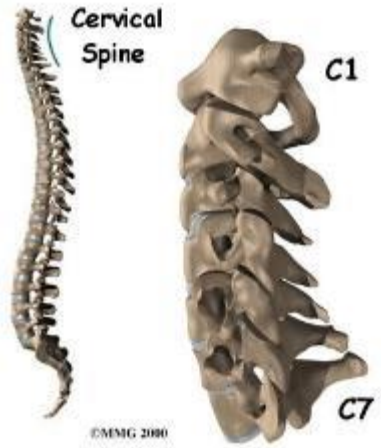
NFL C-Spine Injuries

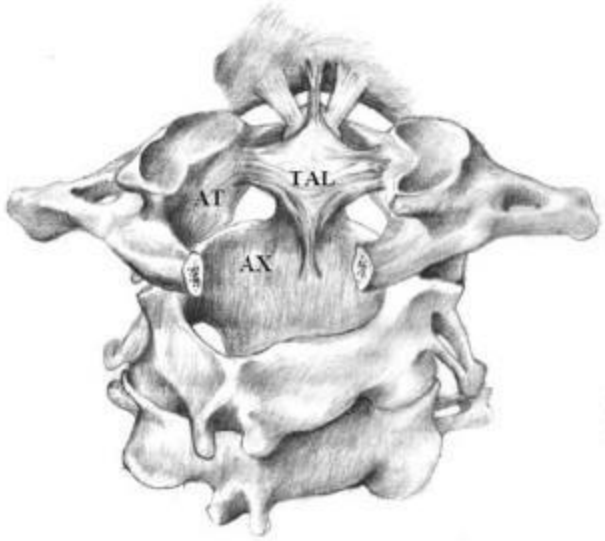
- Mall et al (AJSM 2012) retrospectively reviewed all spine injuries in NFL from 2000-2010

	Injuries, n (%)	Mean Days Lost
Location of injury		
Cervical (n = 987)		19.1
Nerve injury	453 (45.9)	15.3
Muscle injury	214 (21.7)	6.0
Sprain	153 (15.5)	9.6
Disc	57 (5.8)	84.8
Impingement	46 (4.7)	19.3
Other	24 (2.4)	32.9
Contusion	22 (2.2)	21.0
Fracture	18 (1.8)	119.7

Anatomy

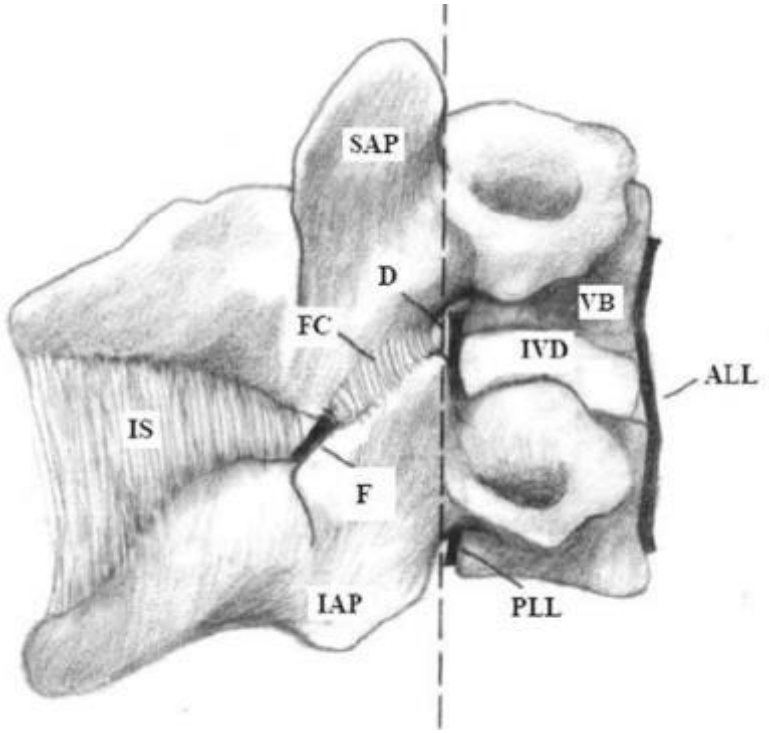
- Upper cervical spine consists of occiput-C2
- Atlantooccipital joint accounts for 40% of flexion/extension
- Atlantoaxial complex 60% of rotation





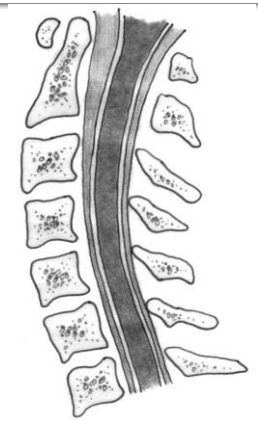
Anatomy

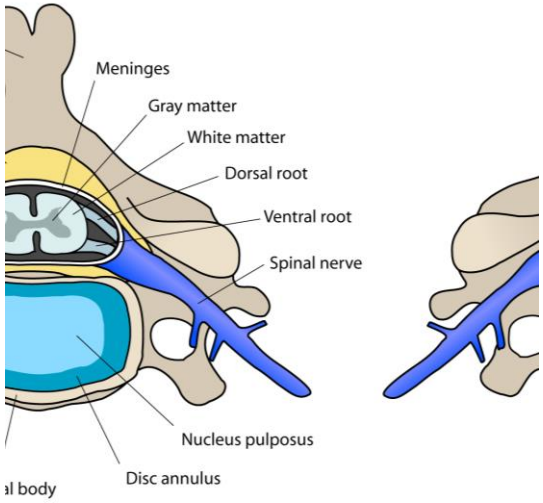
- Lower c spine consists of C3-C7
- Stability derived mainly from anterior elements
- Compression resisted by vertebral bodies, facets and discs
- Distraction by ligaments



Neuroanatomy

- Canal narrows proximal to distal
- Spinal canal
  - Normal canal diameter on lateral radiograph: 14 to 23mm
    - Average: 17mm
  - <13mm indicates cervical stenosis
    - possible cord compression
- Nerve roots exit above the level of the vertebra
  - C5 at C4-5





ON FIELD EVALUATION & MANAGEMENT

MY WORST NIGHTMARE!

My second worst nightmare

On field evaluation & management

- Formulate an "Action Plan" *prior* to season to prevent confusion
  - Organize equipment
    - Spine board, cervical immobilizer, power drill, etc.
  - Select hospital system for transfer
  - Chain of command – Team physician or athletic trainer should be leader
- GOAL: Treat any immediate life-threatening condition while simultaneously preventing further injury

Assessment of the injured athlete

Athlete with neck injury

Loss of consciousness

Immobilize the neck

Consider CPR

Call EMS

No loss of consciousness

neurologic signs or symptoms?

Yes - Call EMS

No - Sideline Evaluation

On field evaluation & management

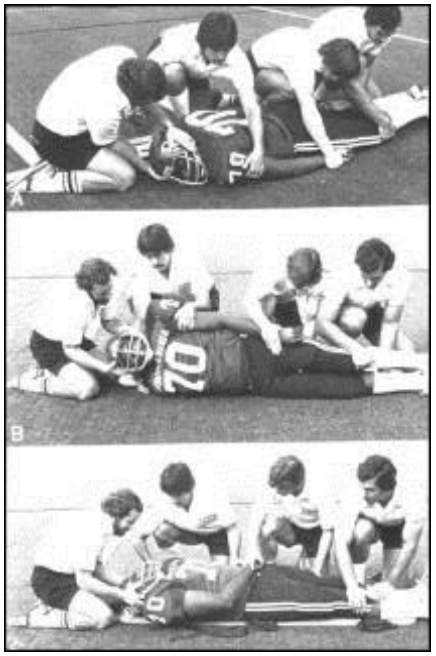
LOC = ATLS guidelines

- 1st priority: CPR, protect the spine, and call EMS
  - Assume C-spine injury until proven otherwise
  - Immobilize head & neck
    - neutral position if possible with manual stabilization
    - NO traction or reduction!
  - Resuscitate as needed
  - Remove facemask, LEAVE helmet & shoulder pads ON

No LOC = 2ary survey

- Get a history
  - Altered mental status?
  - Any numbness, tingling, electricity or pain down the arms and legs?
  - Check for full strength in all four extremities
  - Check for midline cervical tenderness
- If all clear, then take to sideline for full evaluation

Gear Removal and spine board transfer



AMSSM, ACSM and NATA Offer:

- Advanced Team Physician Course
- S.M.A.R.T. Course
- Etc.

Radiographic Evaluation

- Current NCAA Recommendations:
  - Helmet w/o a facemask and shoulder pads should *remain* in place during first X-Rays.
  - CT scan is considered diagnostic in football players with helmet and shoulder pads in place

Steroids – to give or not to give?

- Methylprednisolone is gold-standard
  - 5.4 mg/kg loading dose, then 30 mg/kg for
    - 24 hours if started < 3 hours
    - 48 hours if started < 8 hours
  - Benefit - May Spare one Level
  - Recent studies suggest that it may not be necessary
    - Fear of litigation?

Cervical Sprain/Strain

Acute Cervical Sprain/Strain

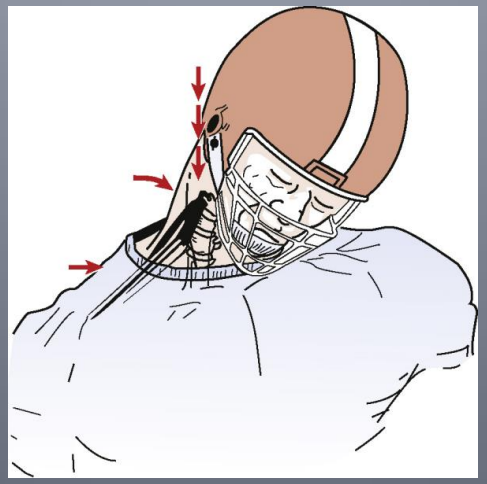
- Strain - Muscle-tendon Injury
  - SCM, trapezius, rhomboid, erector spinae, scalene, levator scapulae
- Sprain - Ligamentous & Capsular Injuries
  - Instability may result

- Symptoms
  - Report "Jamming" neck
  - Localized Cervical Pain
  - No radicular symptoms
- Exam
  - Decreased, painful cervical ROM
  - Tender to palpation
  - Muscle Spasm
  - Normal Neurological exam

Acute Cervical Sprain/Strain Management

- HOLD from play if:
  - Inability to Perform Painless ROM or Any Neurologic Signs
    - C-spine x-ray AP, Lateral, Odontoid
  - Collision + severely limited ROM ➔ immobilize C-spine
    - Rule out facet dislocation
- Return to Play:
  - Pain-Free Full ROM, Strength intact
  - It may be during the same game
- Treatment:
  - Rest, ice, nsaids and muscle relaxer as needed
  - Physical Therapy if not better in 24 hours
- MRI is indicated if:
  - Neurologic Symptoms
  - Persistent/Severe Symptoms – r/o Disc herniation

Burners/Stingers



Burners/Stingers

- Incidence unknown
  - Estimated >50% football player had a stinger at least once
  - Recurrence rate - 87%
- *Transient* episode of shooting/electrical pain or paresthesias radiating down **1** extremity, +/- weakness
  - If bilateral upper extremity—r/o SCI
  - Generally no neck pain
  - Variable duration—usually seconds to minutes
    - Residual Neurologic Deficit for days to months--rare
    - Recurrent Episodes?
      - Rule out cervical stenosis

Chao et al Sports Med 2010

Mechanism of injury

- Mechanism:
  - Stretch or compression injury to cervical nerve root or brachial plexus
    - Tensile more common in younger athletes with weaker neck
    - Compression more likely in older athlete in which cervical extension & rotation narrow neuroforamen
- Typically Upper brachial plexus
  - seldomly C5 nerve root avulsion
- Check for sensory and motor deficits

Imaging

- Diagnostic Imaging Indications:
  - Neck pain +/- limited Cervical ROM
  - Deteriorating strength 2/5 or worse
  - Persistent symptoms
    - weakness > 7 days
  - Recurrent episodes / chronic stingers
    - 93% have cervical stenosis or cervical HNP (Levitz et al. AJSM 1997)

Treatment of Stingers

- Rest
  - control pain/inflammation
  - Consider oral steroids
- Physical Therapy → important in recovering function and preventing recurrence
  - Address neurologic deficits, postural muscles weakness and/or muscle imbalance
- Equipment modification
  - proper shoulder pad fit, shoulder pad lifters, cervical rolls
    - Goal: limit lateral bending → research lacking

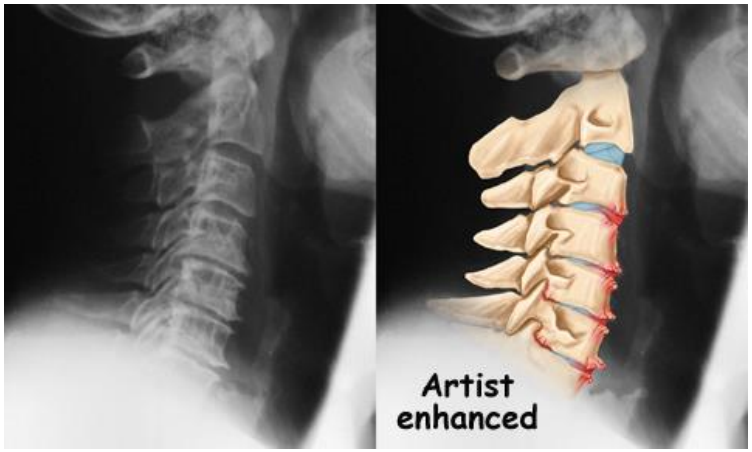
Return to play

- No well-established RTP guidelines
  - Strength intact 5/5 and full painfree ROM
- 1st Episode:
  - May Return to Play Same Game if there is full recovery within 15 minutes
    - Normal Strength/Neurologic Exam
  - Full recovery in 1 week, RTP the following week
- Recurrent Episodes:
  - General rule – No sports for #weeks corresponding to #stingers sustained in given season (ex. 2 weeks for 2 stingers)
    - > 3 stingers/season → consider ending season, especially if:
      - significant weakness with EMG showing axonopathy
      - MRI findings of focal HNP or significant cervical stenosis

Disc disease: HNP and DDD

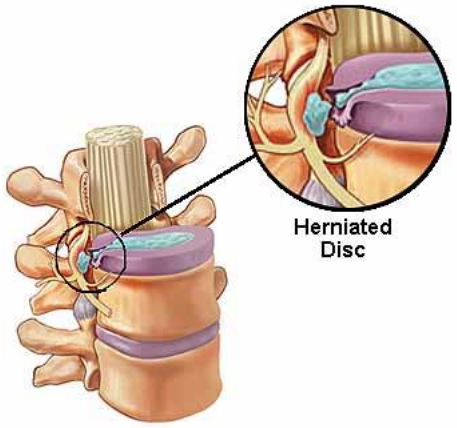
Cervical Disc Disease

- Common Cause of Neck, Shoulder, & Arm Pain
  - It may present as isolated neck pain
- Prevalence 9% in Adults
  - 1% of all athletes at the NFL combine
- Football/wrestling > than General Population
- Two Types
  - Acute HNP
  - Chronic DDD
    - common in athletes (collision)



Acute Herniation of Nucleus Pulposus

- Presentation
  - Acute Neck Pain & Spasm
  - ↓ ROM
  - Radicular Symptoms – Specific Nerve Root
  - Sensory & Motor deficits
- Preferred imaging modality
  - MRI
- Treatment
  - Consider oral steroids
  - Nsaids and muscle relaxer
  - Physical Therapy x 4-6 weeks
  - Consider ESI if MMT ≤3/5



Degenerative Disc Disease Management

- **Conservative**
  - NSAIDs, Traction, Rest, PT, steroid injections
  - usually successful
- RTP: Non-Operatively Treated
  - Asymptomatic, 5/5 strength, full ROM
  - No spinal stenosis

- **Surgical Indications:**
  - Non-op tx fails
  - Progressive neurologic deficit
  - ACDF vs. Posterior Foraminotomy
    - ACDF → standard of care
    - Far Lateral herniation → posterior foraminotomy
- Operatively Treated
  - RTP:
    - One-level ACDF C_{4-5} and below:
    - Radiographic fusion, asymptomatic, normal neuro exam, full ROM
  - Relative Contraindication to RTP (contact):
    - Two level fusion
  - Absolute Contraindication
    - ≥ 3 fusion levels

CCN/TQ and Cervical Stenosis

Transient Quadriplegia

Definition:

- Cervical Cord Neuropraxia "CCN" or Transient Quadriplegia
- Mechanism: Hyperextension injury or axial loading of neck
- Occurs in 7 per 10,000 collegiate football athletes
- Players may have underlying cervical spinal stenosis or disc protrusion.

Signs and Symptoms:

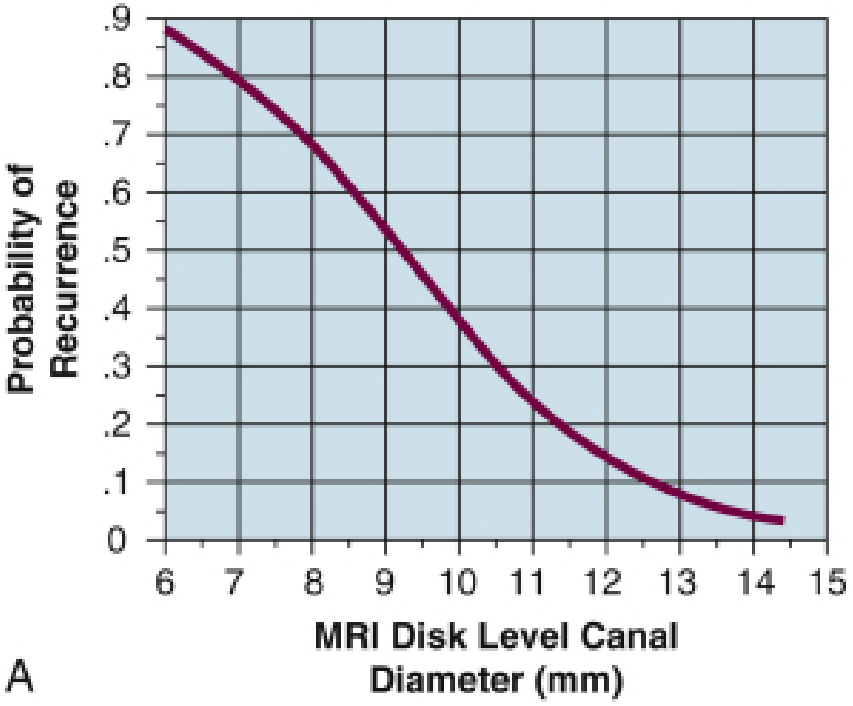
- Sudden numbness, Tingling, and weakness in bilateral arms and legs after a collision → "I felt electricity through my whole body"
- Symptoms transient – Few minutes to 36 hours.

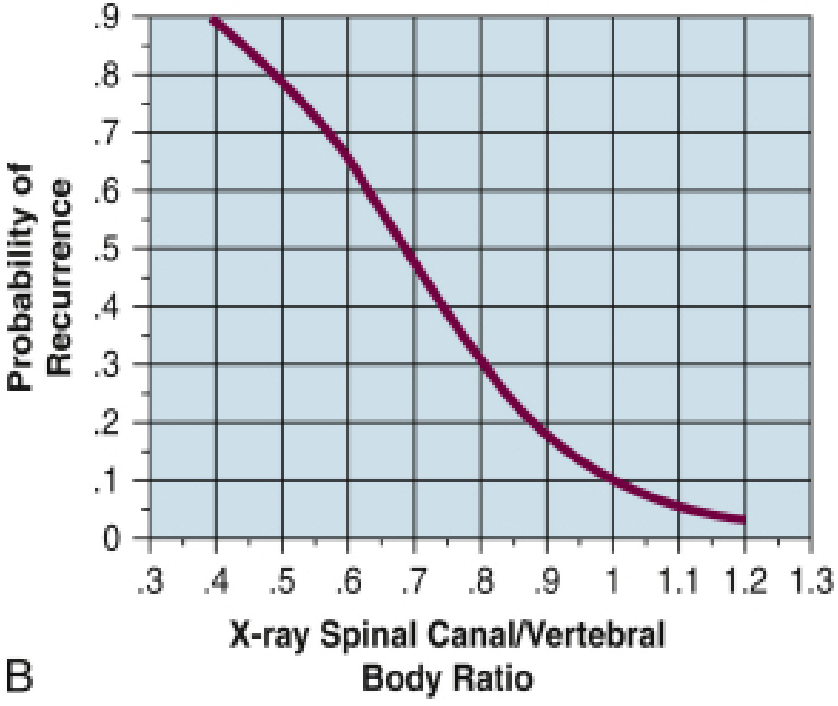
Treatment:

- Immobilize the head and neck, and call EMS.
- Radiography and CT: Evaluate for cervical spine fracture.
- MRI: Evaluate for herniated disc, spinal stenosis, or spinal cord contusion.

Recurrence Rate

- Recurrence as high as 56% in athletes returning to football
- Recurrence rate inversely correlated with canal diameter.





Torg et al J Neurosurgery 1997

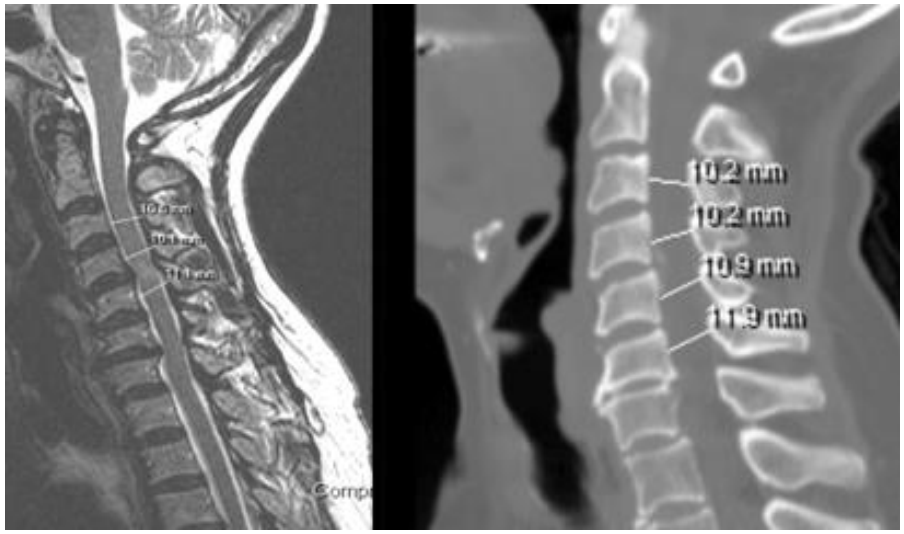
Return to Play

No universal guidelines due to limited data

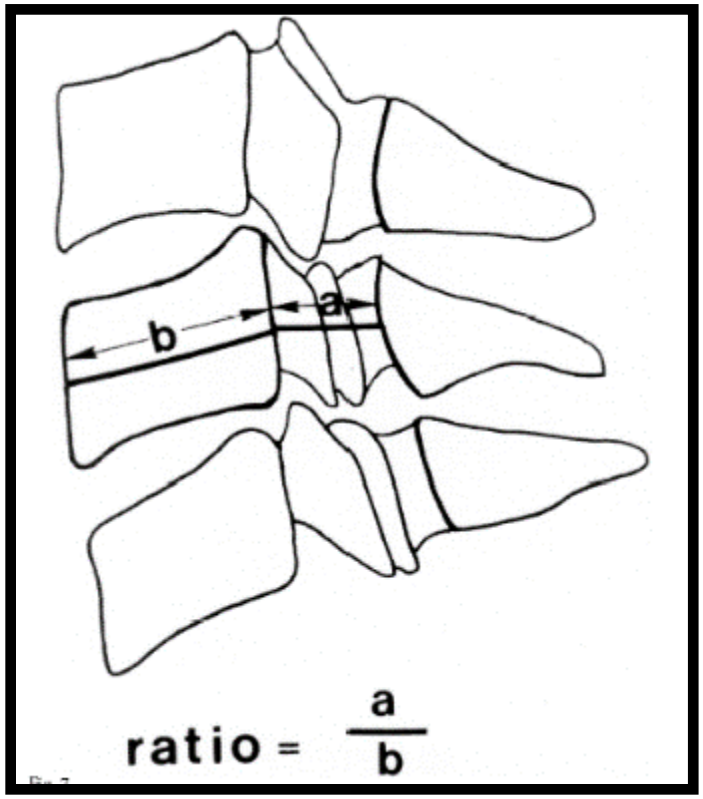
- No contraindication:
  - uncomplicated CCN, Asymptomatic
- Relative contraindication:
  - Mild to moderate spinal stenosis, disk disease
- Absolute contraindications:
  - Severe stenosis, ligamentous instability, cord defect or edema, symptoms >36hrs, &/or >1 episode of transient quadriplegia

Cervical Stenosis

- Narrowed anteroposterior (AP) diameter of cervical spinal canal
  - Acquired - enlargement of facet joints, ligaments, or DDD
  - Congenital - born with narrow canal compared to general population
- Possible symptoms:
  - neuropraxia (permanent or transient), numbness, tingling, or burning
  - Frequently confused with "chronic stingers"



Cervical Stenosis

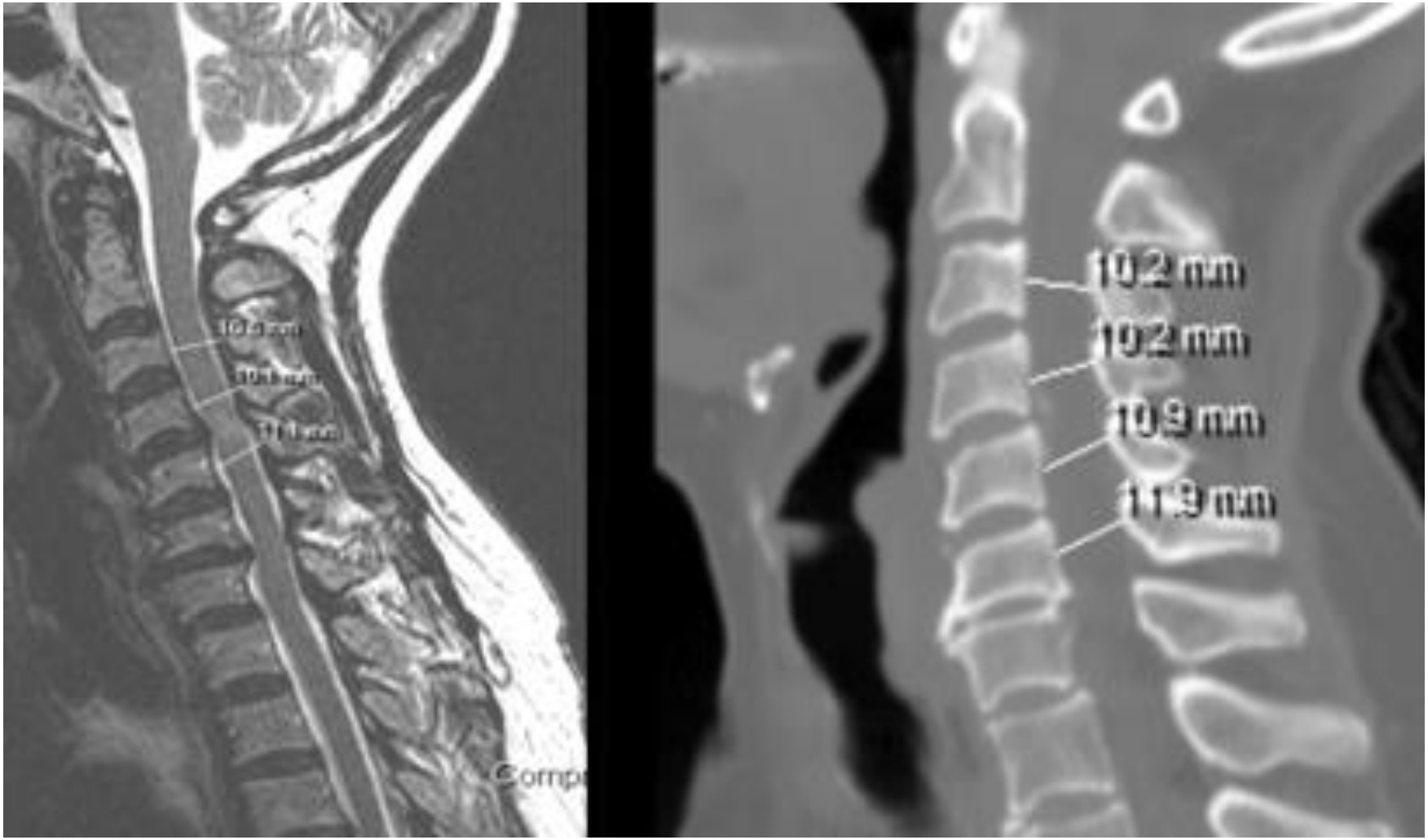


- **Torg ratio** = sagittal diameter of the spinal canal/sagittal midbody diameter of the VB
  - Normal ~ 1.0
  - <0.8 indicates cervical stenosis
- Ratio: High sensitivity, Low specificity
- Not used as screening tool
  - Herzog: 49% asymptomatic NFL players < 0.80
  - Mature football players—large vertebral body decreases Torg ratio despite spinal canal of normal range
- MRI required to fully evaluate stenosis

Cervical Stenosis

- MRI findings:
  - Signal changes in the spinal cord or loss of CSF around the cord
  - Spinal canal diameter:
    - ≥ 13 : no contraindication
    - 10 – 13mm : relative contraindication
    - ≤ 9 : Absolute contraindication
- Treatment:
  - Based on HNP algorythm
  - Rest and nsaids → PT → ESI → surgery
- RTP: controversial
  - evaluate for concurrent instability & degenerative changes
  - Considerations: severity of episode, length of symptoms, amount of canal narrowing, cord signal changes

C spine MRI

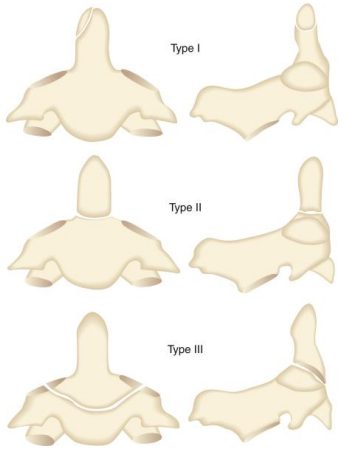


Cervical Fractures

Upper Cervical spine

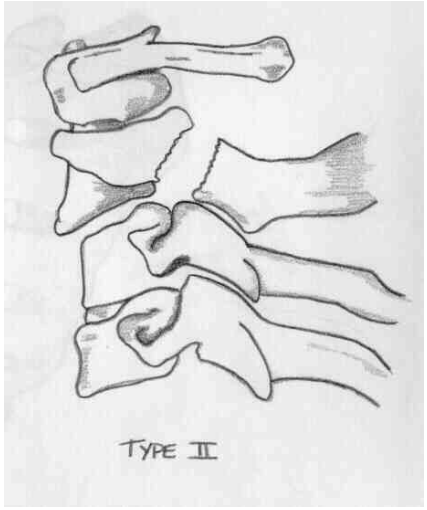
Upper c spine

- Atlantoaxial instability
- Jefferson's fracture
- Hangman's fracture
- Odontoid fracture
- Tear drop fracture



Lower c spine

- Clay shoveler's fracture
- Compression fracture



RTP for contact sports

- No contraindications:
  - Asymptomatic Clay shoveler's fracture
- Relative Contraindications:
  - If patient pain free, full ROM, & no neurologic findings
  - Healed: non-displaced Jefferson fractures, type I and type II odontoid fractures, lateral mass fractures of C2
- Absolute contraindication:
  - A fracture with ligamentous laxity
  - Mal union or non union fracture
  - Burst fracture or hangman's fracture → SCI
  - Spinal cord injury

Cervical Spinous Process Avulsions

- "Clay-Shoveler's Fracture"
  - Common in Football & Power Lifters
  - Most commonly C7 level
  - Stable injuries
- Mechanism:
  - forceful flexion of C-Spine
  - forceful contraction of trapezius & rhomboids
- Treatment:
  - Cervical orthosis, nsaids, and PT
- RTP:
  - 6-8 weeks
  - Healed fracture, Full, painless ROM
  - No neurologic deficits

Spear Tackler's Spine

Rule Changes in Football

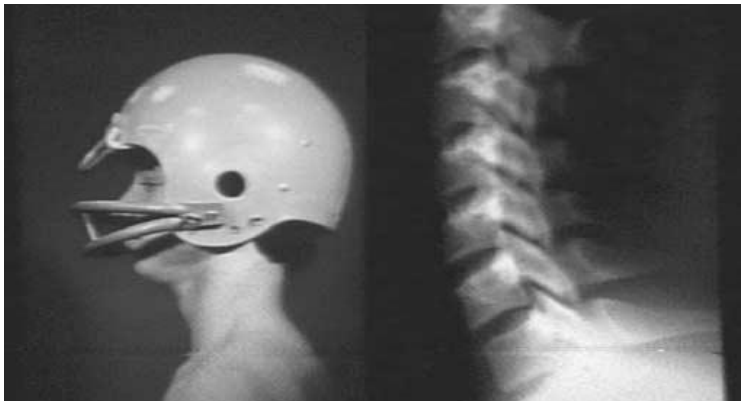
- Improved helmet technology lead to:
  - *decrease* in fatalities due to intracranial hemorrhages
  - *increase* in the incidence of catastrophic cervical spine injuries
- NFL conclusions:
  - modern helmet gave players false sense of security
  - Led to alteration in blocking & tackling techniques (spear-tackling)

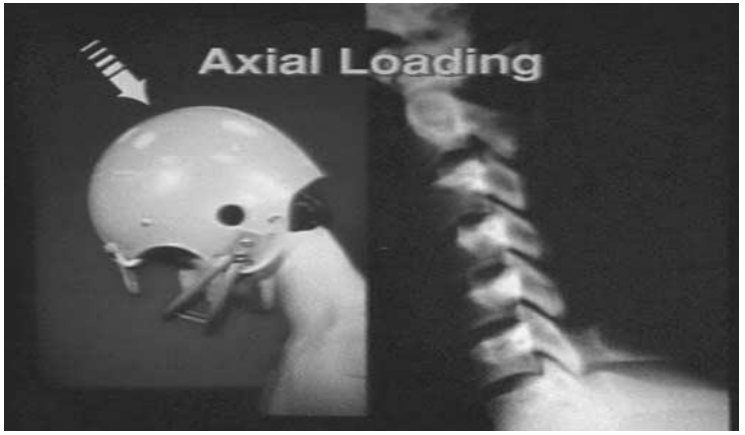
Spear-Tackling

- Spear tackling: intentionally striking an opponent with the crown of the helmet
- Axial load onto a straightened cervical spine can cause SCI
  - Torg et al, *AJSM* 1990

Mechanism

- Response of Vertebral Column to Axial Loading
  - Normal lordosis in C-Spine
    - Energy dissipated through soft tissues
  - Flexion to 30° → Straight C-spine
    - Energy transferred to vertebral bodies and discs

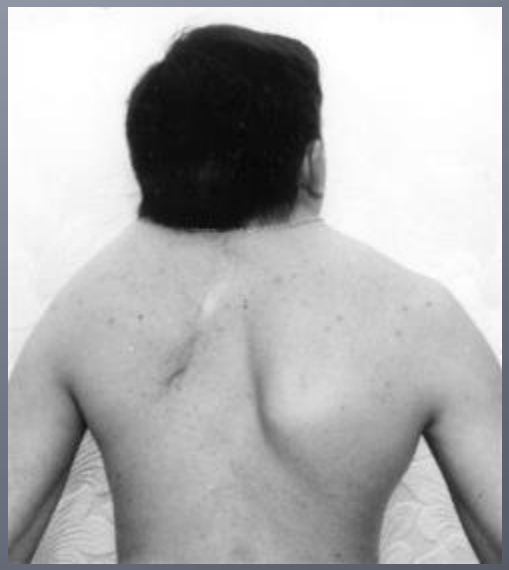




Spear Tackler's Spine

- Identify athletes with increased risk of permanent injury:
  - developmental stenosis
  - loss of cervical lordosis
  - Spondylosis or DDD
  - old compression fractures
  - instability
- Athletes with these predisposed conditions should refrain from contact activities to avoid SCI
- Most effective intervention: EDUCATION & proper tackling techniques

Congenital malformations



Congenital Anomalies

- Altered structural integrity of spinal column
  - predispose collision sport athlete to irreversible & permanent forms of SCI
- Two Categories
  - Failure of Segmentation
  - Failure of Formation

Congenital Anomalies

- Atlanto-Occipital Failure of Segmentation
  - Absolute CI to play collision sports
- Atlanto-Axial Instability
  - Seen in Down Syndrome and advanced RA
  - Absolute CI to play collision sports
- Failure of formation – Odontoid
  - Os Odontoideum, Hypoplasia, or Agenesis
  - All the above can lead to substantial A-A instability
  - Absolute CI to play collision sports
- Spina Bifida Occulta
  - Failure of formation of the posterior arch
  - Usually asymptomatic
  - Spinal biomechanics not significantly altered
  - No CI to collision sports

Klippel-Feil Syndrome

- Fusion of 2 or more vertebrae
  - Decreased motion segments available to dissipate loads
- Torg & Glasgow
  - Type I – long mass fusion
    - **Absolute CI** to play collision sports
  - Type II – 1 or 2 fused segments
    - No CI if:
      - Full cervical ROM
      - No occipito-cervical abnormalities
      - No instability, disc disease or degenerative changes

Thank You!

Questions?

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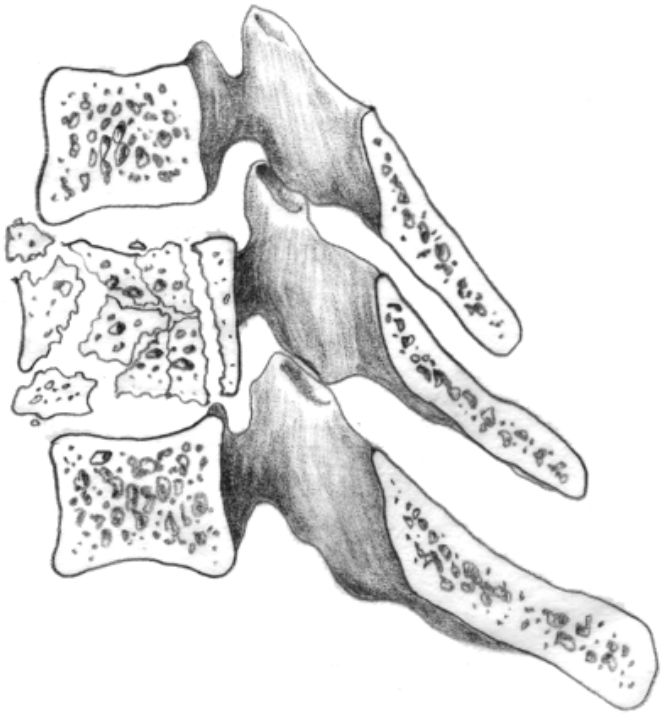
Compression Fractures

- Lower C-spine injury
  - Axial load
  - Evaluate for instability (Flex/Ex, posterior ligamentous injury)
- Management:
  - Stable Compression Fracture: Cervical Orthosis
  - Unstable Compression Fracture: Surgical Fusion
- Return to play:
  - Stable, healed compression fracture
  - Full, painless ROM, no neurologic deficits
  - Fusions may or may not be contraindication
    - Depends on # of levels

Vertical Compression Injury: "Burst"

- Anterior & Middle Column injury → "Burst" Fracture.
- Mechanism:
  - Axial loading with neck in neutral position
  - Often no disruption of posterior soft tissues
  - SCI 2º retropulsed fragments
- Treatment:
  - Stable fracture: hard collar, No posterior injury, SCI
  - Isolated middle column may need Halo treatment
  - Unstable fracture: decompression & fusion
- RTP: dependent on fracture characteristics, SCI & treatment



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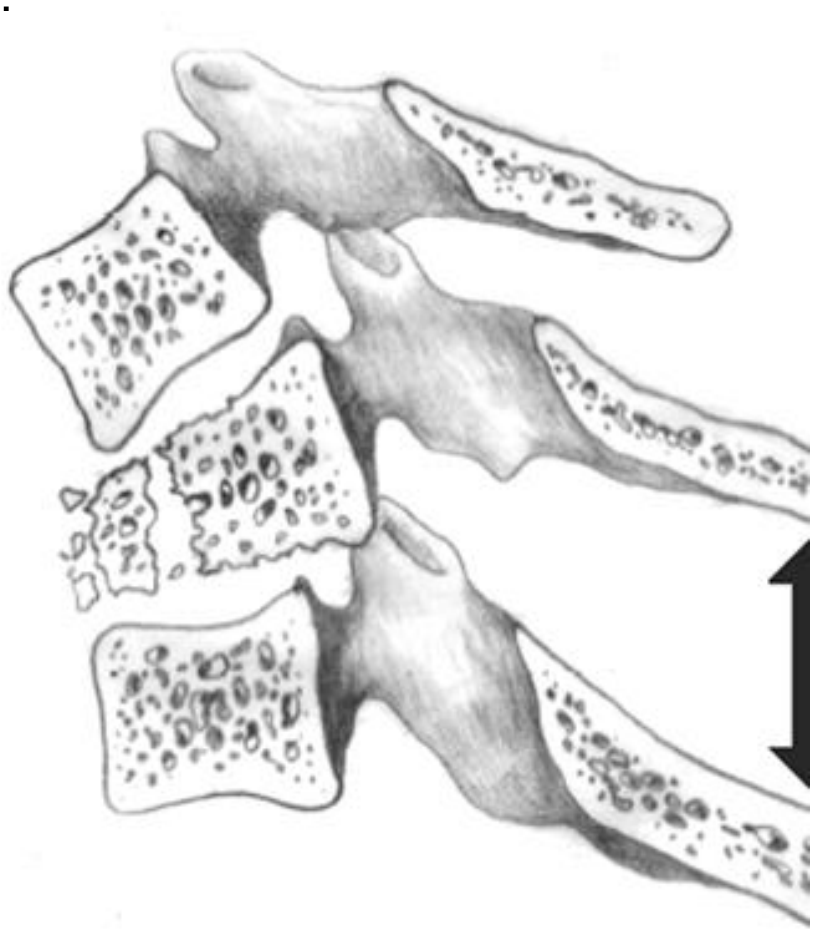
Compressive-Flexion Injury

- Axial force + bending mome
- Pathophysiology
  - Progressive deformation → shortening of anterior column v compressive failure of VB & distraction of posterior column tensile failure of spinal ligamen
- Highly Unstable
- SCI common
- Treatment: surgical fusion
- RTP: related to treatment & neurologic injury



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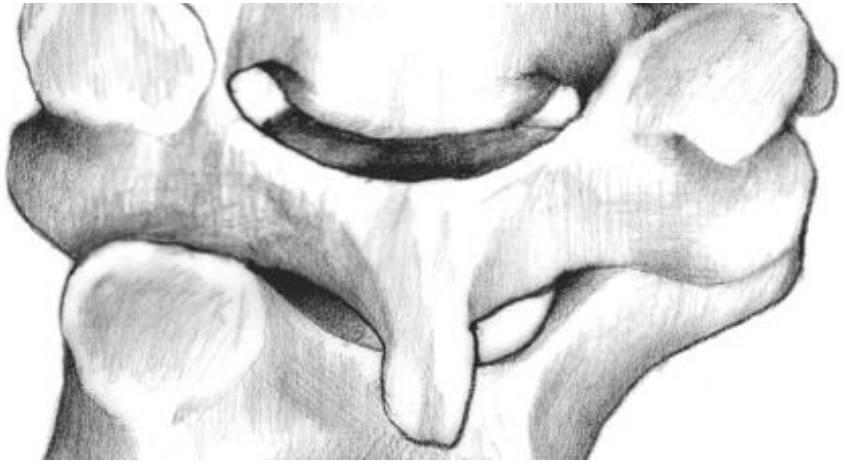
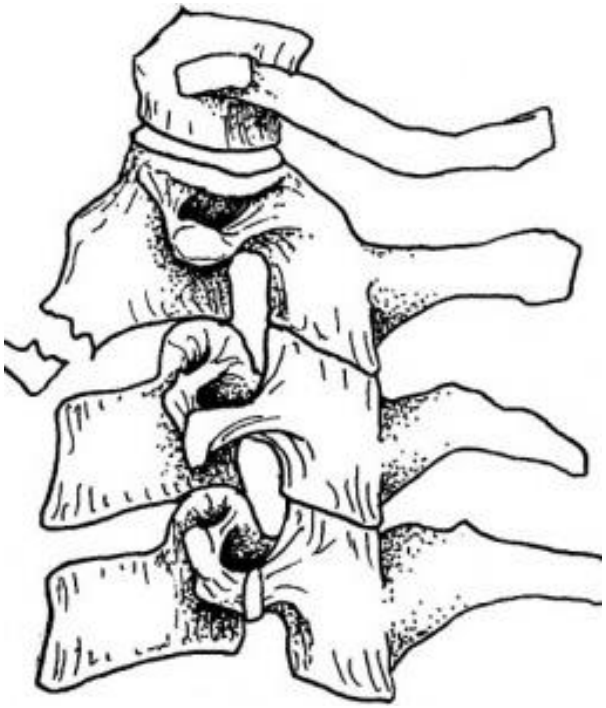
Flexion-Distraction Injuries

- Bilateral & Unilateral facet dislocations
- Direct blow or rapid deceleration
- Mechanism: Hyper-flexion with distraction & rotation
  - Bauze & Ardran JBJS Br 1978
    - Axial loads producing flexion → Bilateral facet dislocations
    - Add lateral tilt or rotation → unilateral facet dislocation
- SCI common
- Treatment
  - Unilateral: certain cases may be treated with Halo/immobilization after reduction
  - Bilateral: Emergent reduction, +/- MRI, & fusion
- RTP
  - Generally do not



Extension "Teardrop" Fracture



- Generally involves C2
- Anterior longitudinal ligament inserts on antero-inferior portion of the body
- Mechanism:
  - Extreme hyperextension, ligament may remain intact but may avulse from its insertion, pulling a corner of the body
  - Vertical height of fracture fragment > than horizontal width of fragment
- Treatment: neck collar for comfort & activity restriction for few weeks
- RTP: Healed fracture, painless ROM, no neurologic deficit

Down's Syndrome

- 1/3 adults with Down syndrome demonstrate radiographic appearance of instability at all levels of the cervical spine
  - only 3% experience neurologic problems
- Down syndrome children & adolescents actively involved in sports activities such as basketball, swimming, and horseback riding
- Treatment
  - ADI < 5 mm: no restrictions
  - ADI=5 mm to <10 mm & physical exam normal: restrict from high-risk sports, including diving, gymnastics, and equestrian events
  - ADI >10 mm: spinal fusion: no collision sports
  - Surgical stabilization in those with neurologic dysfunction & instability