Cervical Spine Injuries & Return to Activities
Yakima Medical Conference

Eric S. Varley, DO
Minimally Invasive & Complex Spine Surgery
Virginia Mason Franciscan Health
Seattle, Washington

March 11, 2023

Virginia Mason Franciscan Health

Disclosures

- None

Virginia Mason Franciscan Health

My Background

- **EDUCATION**
  - College in Kalamazoo
  - Medical School in Florida
  - NIH Training in Scoliosis
  - Residency in Grand Rapids
  - Fellowship in San Diego

Virginia Mason Franciscan Health

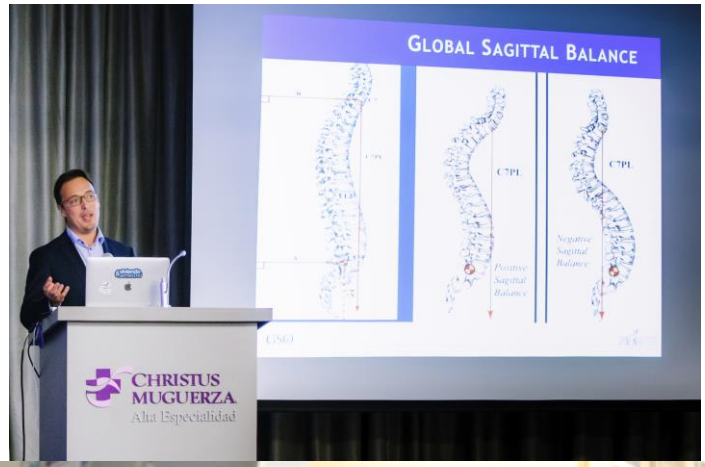
Professional Interests

- Non-operative & Operative General Spine Care
- Minimally Invasive Spine Surgery
- Complex Deformity Surgery
- Revision Spine Surgery

Virginia Mason Franciscan Health

Professional Interests

- Serve Local & Global Community
  - Serve annually in Uganda & Columbia performing spine surgeries
  - Lecture and teach trainees internationally



Virginia Mason Franciscan Health

Thank You for Being Here

- **Agenda**
  - Basic Epidemiology
  - Biomechanics & Prevention
  - Differential Diagnosis
  - Stingers
  - Fractures
  - Spinal Cord Injuries
  - Return to activity evidence
  - Take Home Points

Virginia Mason Franciscan Health

So Lets Talk Some Spine

Virginia Mason Franciscan Health

Epidemiology

- **Sports Participation (2013-2014)[1]**
  - >7.7MIL High School & >460K College
  - Football: >1.1MIL High School & >70K College

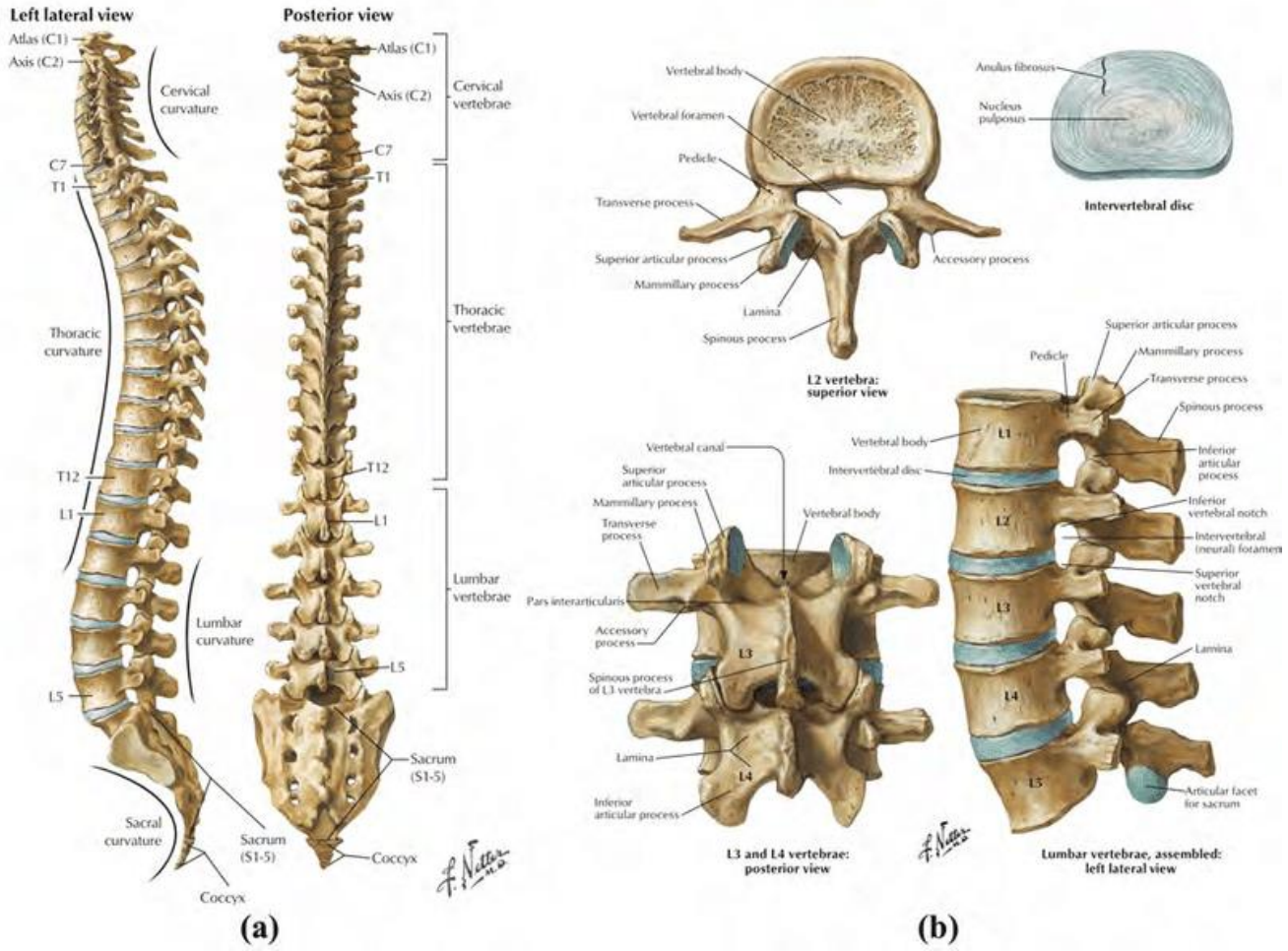
- **Spine Injuries in Sports[1]**
  - Spine = 9 to 15% all athletic injuries

- **Spinal Cord Injury[2]**
  - SCI cases 40 cases per 1 million Americans (12,500 cases/year)
  - MVA (40%), Falls (30%), Violence (14%), *Sports (9%)*
  - Stingers/Burners: Up to 70% College football players within 4 years
  - Athletic related hospitalizations: 2.4% due to SCI

1. National Spinal Cord Injury Statistical Center (NSCISC). *Spinal Cord Information Network*. University of Alabama at Birmingham; 2014.
2. Maroon JC. Athletes with cervical spine injury. *Spine* 1996.

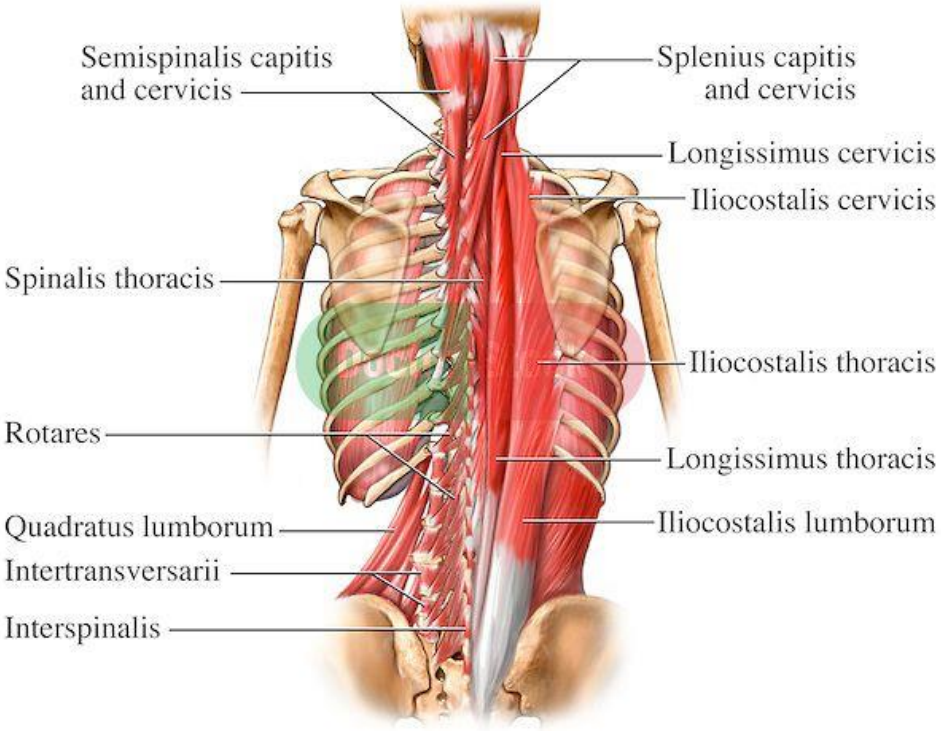
Virginia Mason Franciscan Health

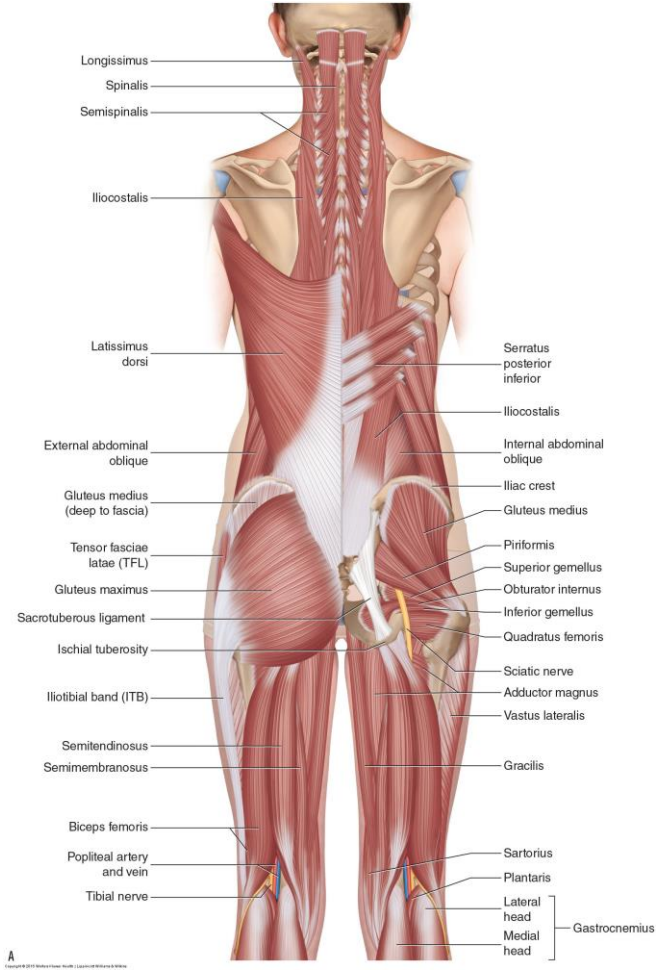
Spine Anatomy: Bones



Virginia Mason Franciscan Health

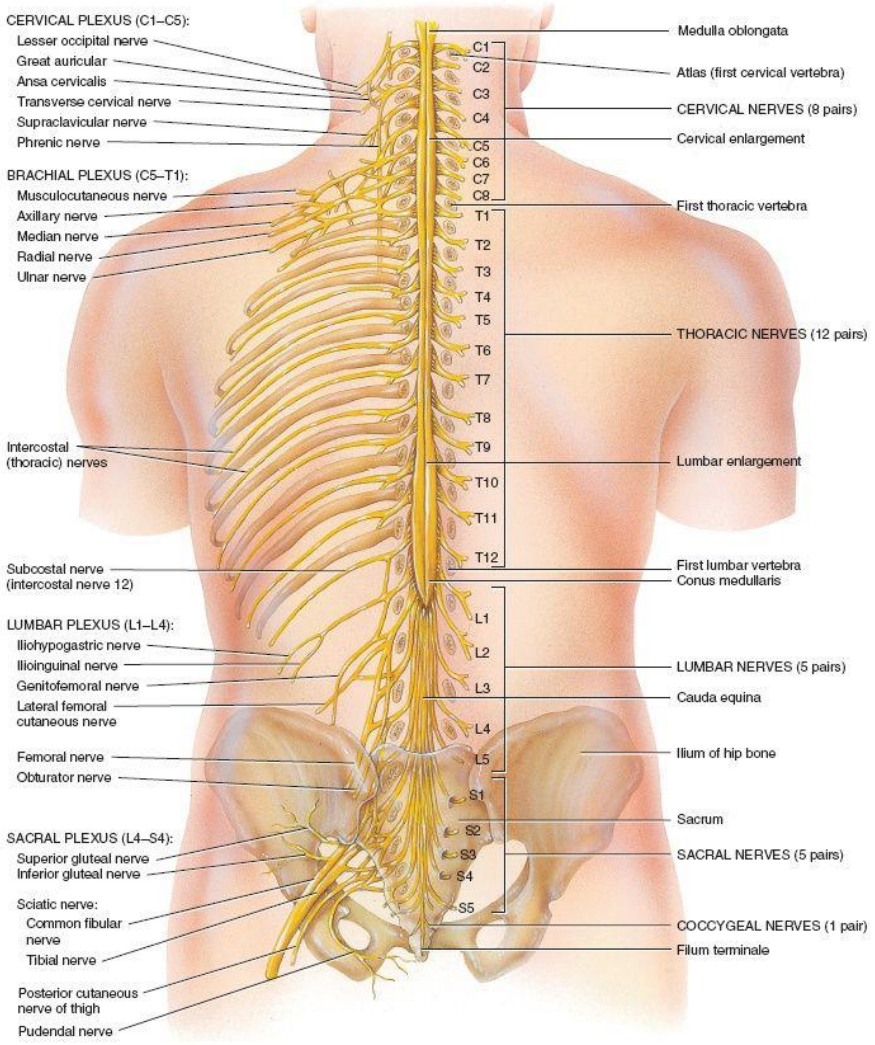
Spine Anatomy: Muscles



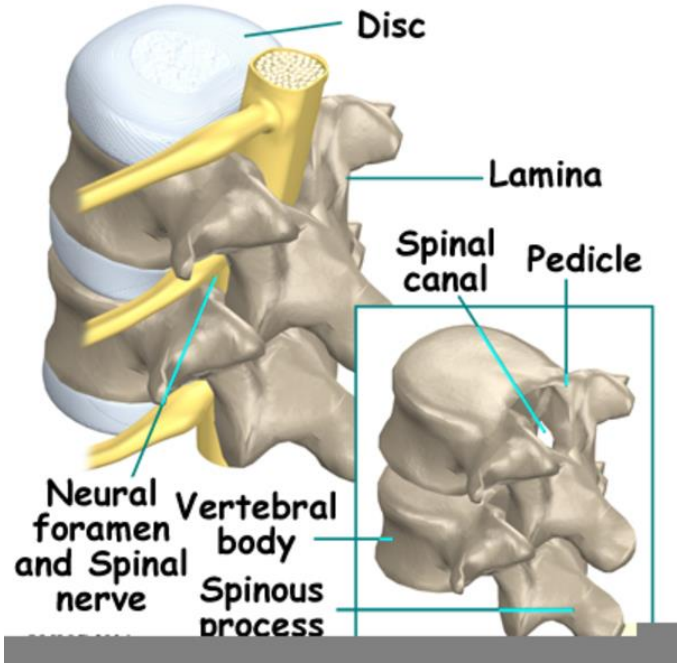


Virginia Mason Franciscan Health

Spine Anatomy: Nerves

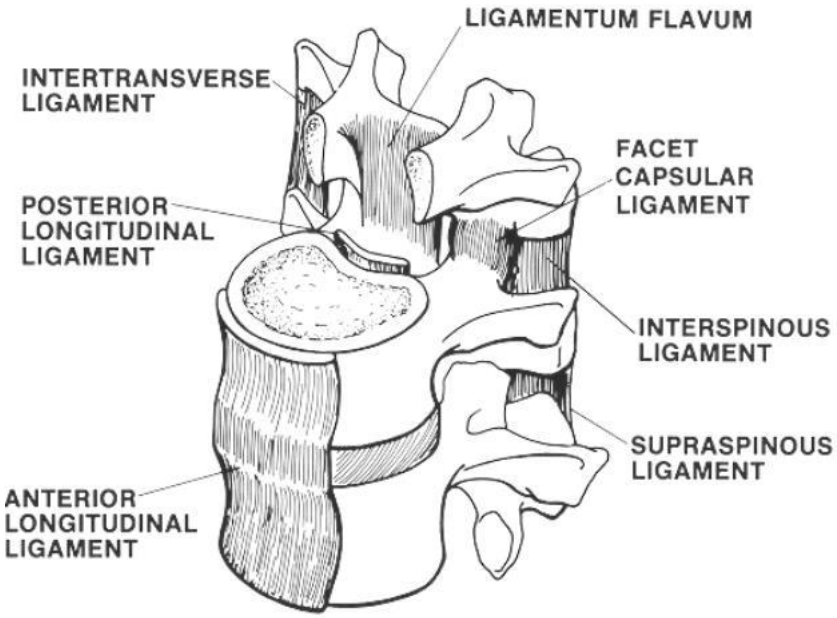


Posterior view of entire spinal cord and portions of spinal nerves



Virginia Mason Franciscan Health

Spine Anatomy: FSU



FUNCTIONAL SPINAL UNIT

- 2 vertebral bodies
- Intervertebral Disc
- Facet Joints
- Ligaments & Muscle

Virginia Mason Franciscan Health

Biomechanics of Injury

- **Cervical spine injury is a HUGE spectrum**
- **Evaluating biomechanical milieu**

1. What is the mechanism?
2. Which part of the spine is affected?
3. Which tissues are predominantly affected?
4. Individual characteristics that impact vulnerability to specific injury?

Virginia Mason Franciscan Health

Soft Tissue Injuries

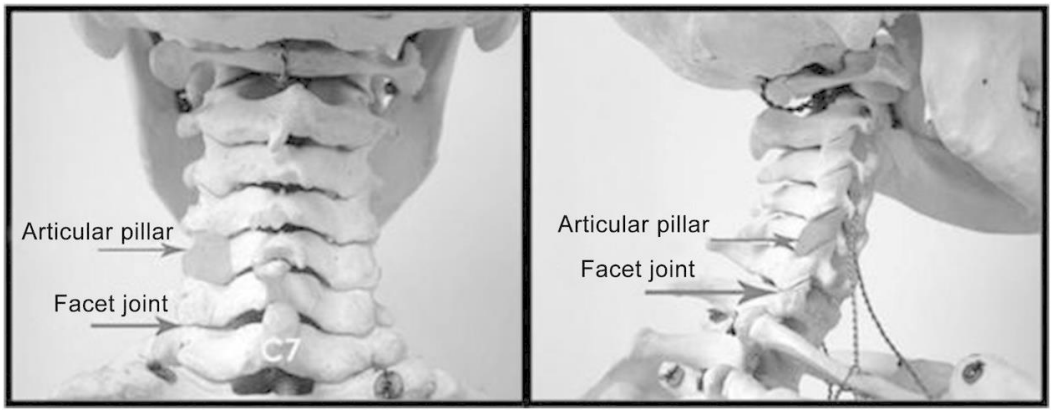
- **Indirect Loading**
  - Most Common Mechanism
  - Chronic: Sustained, high rep

- **High Energy**
  - Rare / Catastrophic
  - Violent rotation/bending MOI
  - Occur with bone/disc injury

Virginia Mason Franciscan Health

Spine Joint Injuries

- **Cervical articular pillars**
  - Facet + lateral masses
  - Carry high % axial load
  - Vulnerable

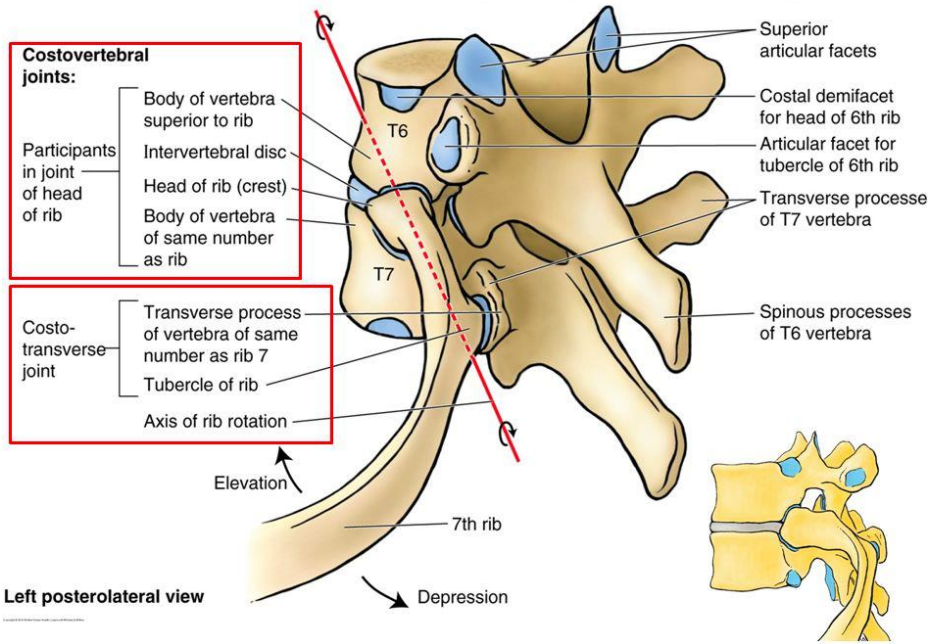


- **Thoracic facets**
  - Oriented vertically
  - Rib Cage increased stability
  - MOI: rapid flexion/extension
- **Lumbar facets**
  - Most common
  - MOI: rotational forces

Virginia Mason Franciscan Health

Spine Joint Injuries

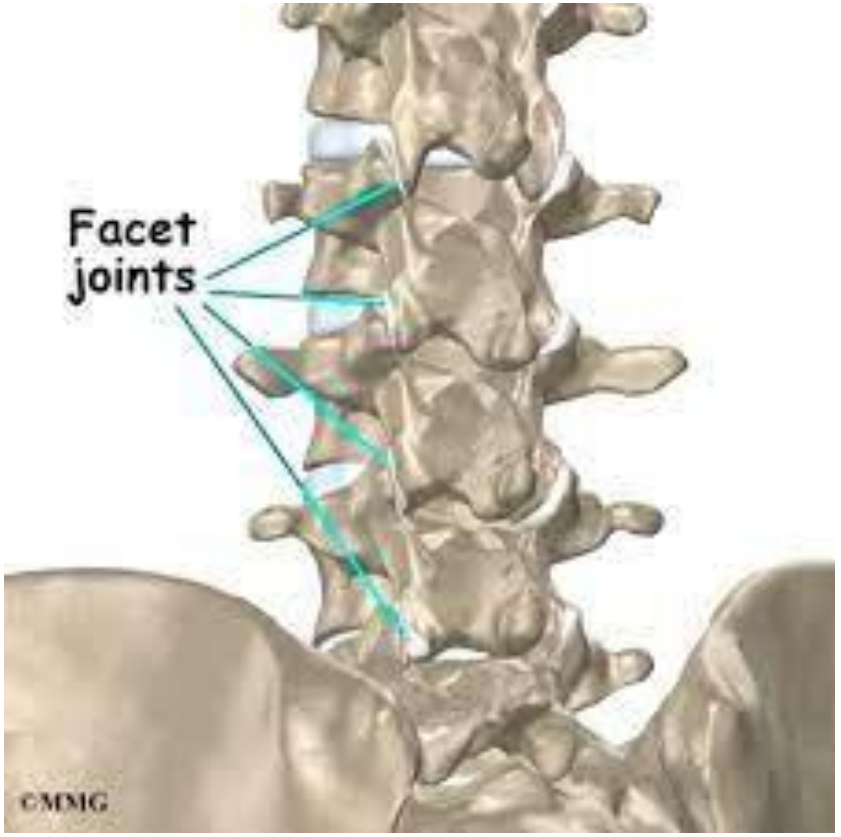
- **Cervical articular pillars**
  - Facet + lateral masses
  - Carry high % axial load
  - Vulnerable
- **Thoracic facets**
  - Oriented vertically
  - Rib Cage increased stability
  - MOI: rapid flexion/extension
- **Lumbar facets**
  - Most common
  - MOI: rotational forces



Virginia Mason Franciscan Health

Spine Joint Injuries

- **Cervical articular pillars**
  - Facet + lateral masses
  - Carry high % axial load
  - Vulnerable
- **Thoracic facets**
  - Oriented vertically
  - Rib Cage increased stability
  - MOI: rapid flexion/extension
- **Lumbar facets**
  - Most common
  - MOI: rotational forces



Virginia Mason Franciscan Health

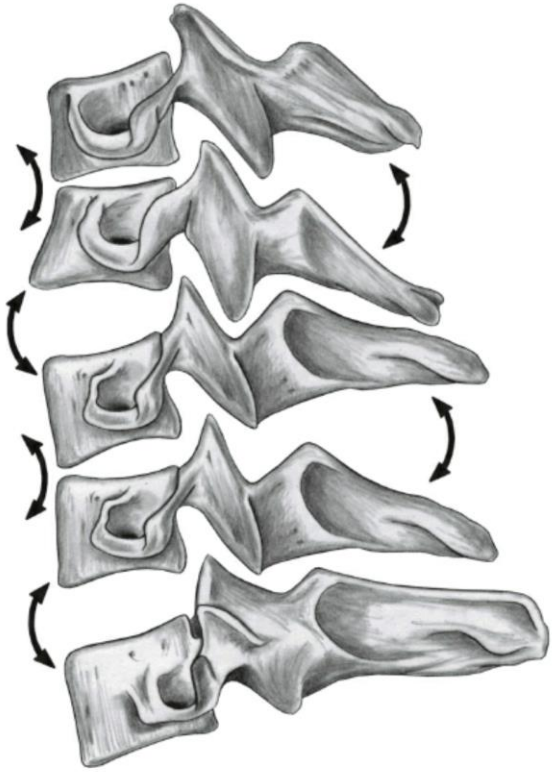
Spinal Cord Injuries

- Varies drastically by anatomic region
- Most common mechanism is axial load in cervical spine
- Sports is 2nd most common mechanism of SCI in <30 year old
- Stay tuned…

Virginia Mason Franciscan Health

Regional Biomechanics: Cervical

- **Relatively small size cervical spine relative head[1]**
  - 20% stability: osteoligamentous structures.
  - 80% stability: strong anterior & posterior neck muscles.
- **Mechanism of Injury[2]**
  - Initial thought head movement > spine ROM
  - <u>Buckling theory</u>
    - Forces spine into complex shape
    - Regions of pure compression, compression-flexion, compression-flexion
    - 16 kg of mass at speed 3.1 m/s required disrupt cervical spine

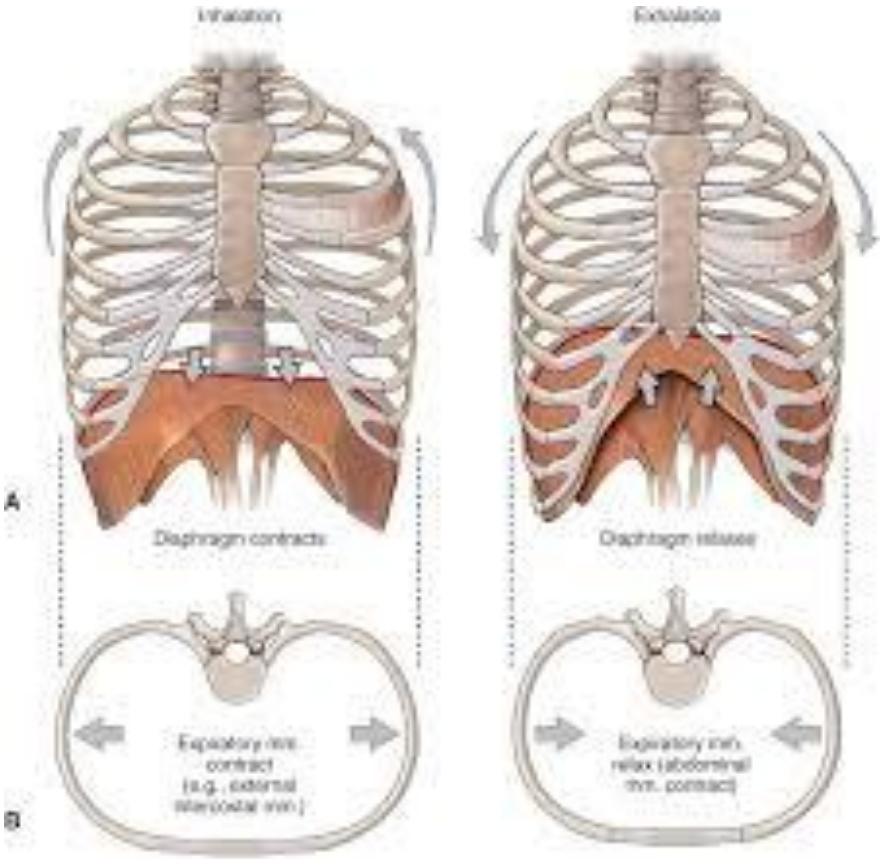


1. Schmidt JD. The influence of cervical muscle characteristics on head impact biomechanics in football. Am J Sports Med 2014.
2. Nightingale RW. Experimental impact injury to the cervical spine: Relating motion of the head and the mechanism of injury. J Bone Joint Surg Am 1996.

Virginia Mason Franciscan Health

Regional Biomechanics: Thoracic

- Less common vs. Cervical & Lumbar
- Rib cage = “Fourth Column”[1]
- Adds torsional power for throwing activities[2]

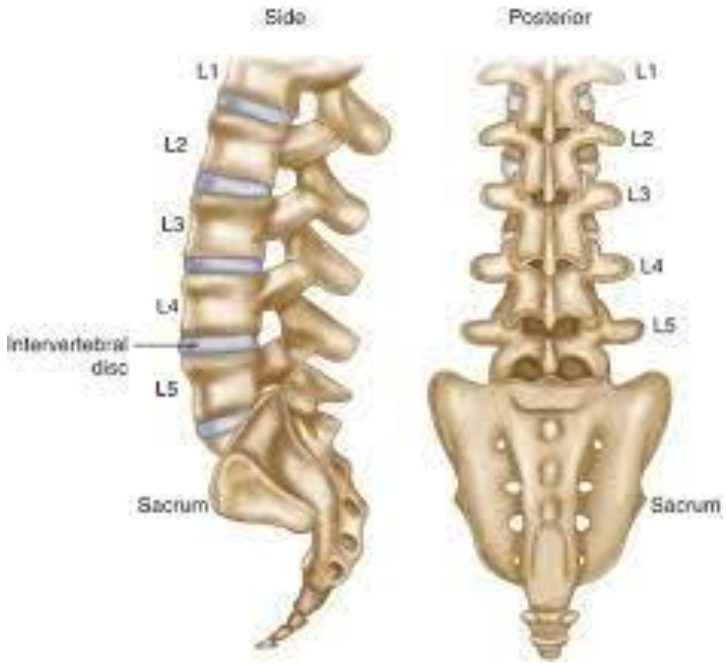


1. Berg EE: The sternal-rib complex. A possible fourth column in thoracic spine fractures. Spine 1993.
2. Hecht, Andrew. Spine Injuries in Athletes . Wolters Kluwer Health. Kindle Edition.

Virginia Mason Franciscan Health

Regional Biomechanics: Lumbar

- Chronic overloading can lead to spondylotic change.
- Acute loading may lead to compression or burst fractures.
- Sports injuries, destabilizing spine fractures are less common.[1]



1. Hecht, Andrew. Spine Injuries in Athletes . Wolters Kluwer Health Kindle Edition.

Virginia Mason Franciscan Health

Cervical Spine

Virginia Mason Franciscan Health

"On Field" Evaluation

Cervical

- Observe mechanism of injury

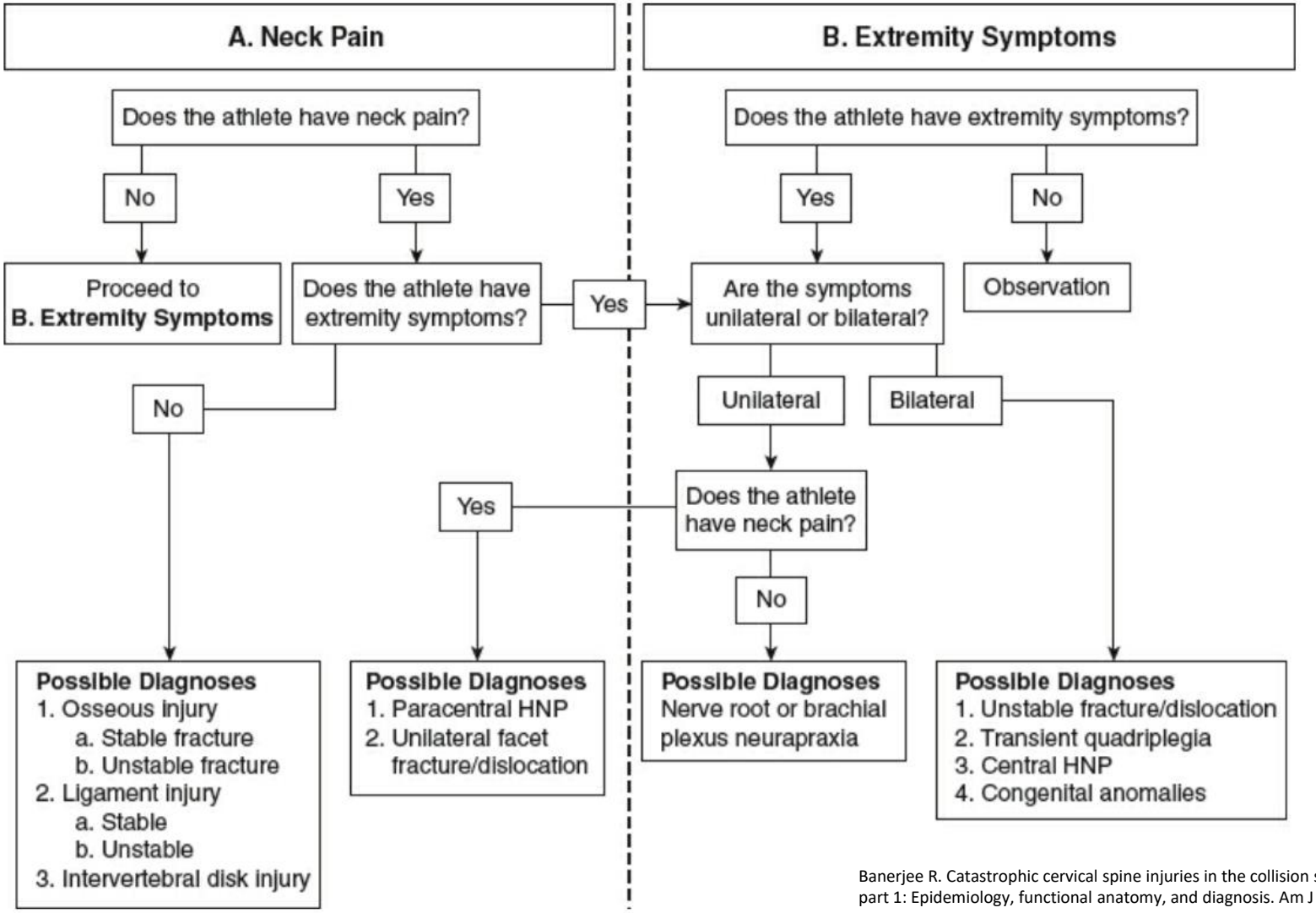
- Athletes with LOC or Altered Mental Status presumed cervical spine injury until proven otherwise

- Follow neck pain algorithm

Virginia Mason Franciscan Health

"On Field" Evaluation

Cervical

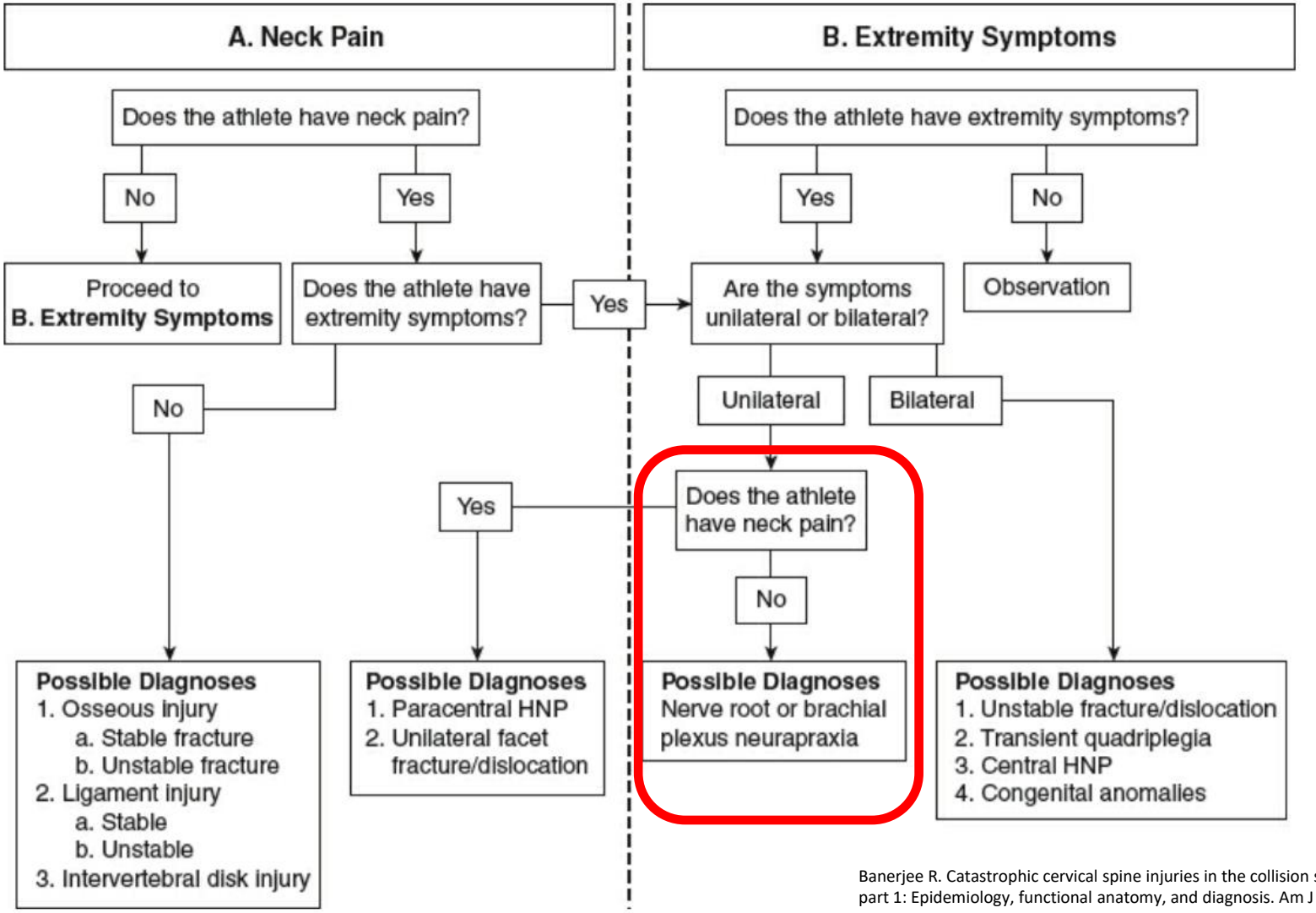


Banerjee R. Catastrophic cervical spine injuries in the collision sport athlete, part 1: Epidemiology, functional anatomy, and diagnosis. Am J Sports Med 2004.

Virginia Mason Franciscan Health

On Field Evaluation

cervical



Banerjee R. Catastrophic cervical spine injuries in the collision sport athlete, part 1: Epidemiology, functional anatomy, and diagnosis. Am J Sports Med 2004.

Virginia Mason Franciscan Health

On Field Evaluation

Cervical

- **If a structural or neurologic injury is suspected**
  - Immobilization (rigid collar & backboard)
  - Remove face mask, maintain helmet

- **RED FLAGS**[1]
  - LOC or AMS
  - Bilateral neurologic symptoms
  - Focal spine pain/tenderness
  - GCS <8 associated C spine injury

1. Schroeder G. Cervical Spine Injuries in the Athlete. JAAOS 2016.

Differential Diagnosis

cervical

Diagnosis	Primary Complaint	Associated Symptoms	Pertinent Negatives	Examination Findings and Keys	Clinical Example
Cervical sprain or strain	Paraspinal soreness and tightness Often follows a traumatic event	Pain to anterior cervical muscles or intrinsic and extrinsic cervical muscles	Neurologic symptoms typically absent	Muscular tenderness ROM limited by pain Normal neurologic examination results	"Whiplash" to neck in collision or motor sport athlete
Cervical facet dislocation	New-onset torticollis and loss of motion after high-energy trauma	Neurologic symptoms often present	No extremity tenderness in the absence of extremity injury	Spinal tenderness with asymmetric loss of motion Perform full neurologic exam or MRI before reduction	Rotational injury after "facemask" tackle in American football
Cervical DJD or DDD	Axial neck pain Worst at extremes of motion	Stiffness often present Neurologic symptoms are variably present	Minimal paraspinal tenderness No extremity tenderness	Axial symptoms outweigh radicular symptoms	"Spear tackler's spine" in athlete with a history repetitive axial load to the cervical spine
Cervical radiculopathy	Radiating neurologic pain, numbness, paresthesias, or weakness Pain worsens with distinct movements or positions of the neck	Neck pain may also be present if associated with DDD	Palpation of the symptomatic area does not reproduce pain	Radicular symptoms outweigh axial symptoms Myelopathic signs should be absent in pure radiculopathy Extremity pain improved with shoulder abduction	Radicular symptoms with or without an inciting event May be exacerbated by cervical rotation and upward gaze (e.g., with a tennis serve)

Differential Diagnosis

cervical

Diagnosis	Primary Complaint	Associated Symptoms	Pertinent Negatives	Examination Findings and Keys	Clinical Example
Cervical sprain or strain	Paraspinal soreness and tightness Often follows a traumatic event	Pain to anterior cervical muscles or intrinsic and extrinsic cervical muscles	Neurologic symptoms typically absent	Muscular tenderness ROM limited by pain Normal neurologic examination results	"Whiplash" to neck in collision or motor sport athlete
Cervical facet dislocation	New-onset torticollis and loss of motion after high-energy trauma	Neurologic symptoms often present	No extremity tenderness in the absence of extremity injury	Spinal tenderness with asymmetric loss of motion Perform full neurologic exam or MRI before reduction	Rotational injury after "facemask" tackle in American football
Cervical DJD or DDD	Axial neck pain Worst at extremes of motion	Stiffness often present Neurologic symptoms are variably present	Minimal paraspinal tenderness No extremity tenderness	Axial symptoms outweigh radicular symptoms	"Spear tackler's spine" in athlete with a history repetitive axial load to the cervical spine
Cervical radiculopathy	Radiating neurologic pain, numbness, paresthesias, or weakness Pain worsens with distinct movements or positions of the neck	Neck pain may also be present if associated with DDD	Palpation of the symptomatic area does not reproduce pain	Radicular symptoms outweigh axial symptoms Myelopathic signs should be absent in pure radiculopathy Extremity pain improved with shoulder abduction	Radicular symptoms with or without an inciting event May be exacerbated by cervical rotation and upward gaze (e.g., with a tennis serve)

Differential Diagnosis

cervical

Diagnosis	Primary Complaint	Associated Symptoms	Pertinent Negatives	Examination Findings and Keys	Clinical Example
Cervical sprain or strain	Paraspinal soreness and tightness Often follows a traumatic event	Pain to anterior cervical muscles or intrinsic and extrinsic cervical muscles	Neurologic symptoms typically absent	Muscular tenderness ROM limited by pain Normal neurologic examination results	"Whiplash" to neck in collision or motor sport athlete
Cervical facet dislocation	New-onset torticollis and loss of motion after high-energy trauma	Neurologic symptoms often present	No extremity tenderness in the absence of extremity injury	Spinal tenderness with asymmetric loss of motion Perform full neurologic exam or MRI before reduction	Rotational injury after "facemask" tackle in American football
Cervical DJD or DDD	Axial neck pain Worst at extremes of motion	Stiffness often present Neurologic symptoms are variably present	Minimal paraspinal tenderness No extremity tenderness	Axial symptoms outweigh radicular symptoms	"Spear tackler's spine" in athlete with a history repetitive axial load to the cervical spine
Cervical radiculopathy	Radiating neurologic pain, numbness, paresthesias, or weakness Pain worsens with distinct movements or positions of the neck	Neck pain may also be present if associated with DDD	Palpation of the symptomatic area does not reproduce pain	Radicular symptoms outweigh axial symptoms Myelopathic signs should be absent in pure radiculopathy Extremity pain improved with shoulder abduction	Radicular symptoms with or without an inciting event May be exacerbated by cervical rotation and upward gaze (e.g., with a tennis serve)

Differential Diagnosis

cervical

Diagnosis	Primary Complaint	Associated Symptoms	Pertinent Negatives	Examination Findings and Keys	Clinical Example
Cervical sprain or strain	Paraspinal soreness and tightness Often follows a traumatic event	Pain to anterior cervical muscles or intrinsic and extrinsic cervical muscles	Neurologic symptoms typically absent	Muscular tenderness ROM limited by pain Normal neurologic examination results	"Whiplash" to neck in collision or motor sport athlete
Cervical facet dislocation	New-onset torticollis and loss of motion after high-energy trauma	Neurologic symptoms often present	No extremity tenderness in the absence of extremity injury	Spinal tenderness with asymmetric loss of motion Perform full neurologic exam or MRI before reduction	Rotational injury after "facemask" tackle in American football
Cervical DJD or DDD	Axial neck pain Worst at extremes of motion	Stiffness often present Neurologic symptoms are variably present	Minimal paraspinal tenderness No extremity tenderness	Axial symptoms outweigh radicular symptoms	"Spear tackler's spine" in athlete with a history repetitive axial load to the cervical spine
Cervical radiculopathy	Radiating neurologic pain, numbness, paresthesias, or weakness Pain worsens with distinct movements or positions of the neck	Neck pain may also be present if associated with DDD	Palpation of the symptomatic area does not reproduce pain	Radicular symptoms outweigh axial symptoms Myelopathic signs should be absent in pure radiculopathy Extremity pain improved with shoulder abduction	Radicular symptoms with or without an inciting event May be exacerbated by cervical rotation and upward gaze (e.g., with a tennis serve)

Differential Diagnosis

cervical

Peripheral nerve injury	Extremity neurologic pain, numbness, paresthesias or weakness	May be exacerbated by extremity position	No neck pain No exacerbation with neck motion	See Table 9-5	Ulnar neuropathy associated with elbow MCL insufficiency in a pitching athlete
Rotator cuff tear or tendinitis	Shoulder pain and weakness	Pain may radiate to neck	Absence of neurologic symptoms	Symptoms worsen with shoulder abduction Subacromial anesthetic injection improves pain and may improve weakness	Subacromial impingement resulting in rotator cuff tendinitis in an overhead athlete
Glenoid labrum injury	Pain with abduction/external rotation (anterior labrum), adduction or loading (posterior labrum), or overhead activity (superior labrum)	Glenohumeral instability or apprehension with certain arm positions	Absence of neurologic symptoms	Neck pain is infrequent Symptoms maximal when in an "at-risk" position for the shoulder	Shoulder instability after glenohumeral dislocation
Glenohumeral DJD	Shoulder pain or grinding, with or without stiffness	Pain may radiate to neck Pain-limited weakness	Absence of neurologic symptoms	Symptoms are worst at the extremes of shoulder motion Glenohumeral injection improves pain and strength	Accelerated joint wear caused by upper extremity weight bearing in a wheelchair athlete or weight lifter

DDD = degenerative disk disease, DJD = degenerative joint disease, MCL = medial collateral ligament, ROM = range of motion.

Nerve Injuries: Stingers

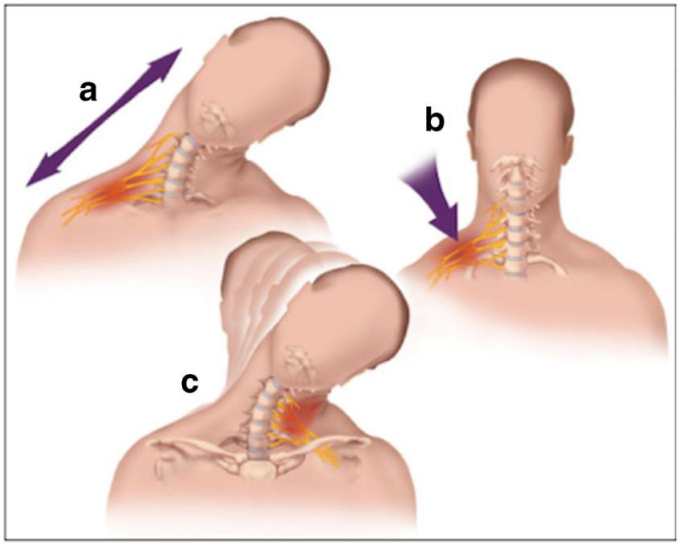
cervical

Virginia Mason Franciscan Health

Nerve Injuries: Stingers

Cervical

- **Forceful contact to the neck or upper extremities[1]**
- **Temporary sensory & motor deficits to single upper extremity (Stingers or Burners)**
  - Most Common: sharp pain, ROM ↓
  - Motor varies: transient weak - paralysis
- **Typically lasts from seconds to 24 hours, can last up to 2 weeks[2]**
- **Common injuries in American football**
  - NFL recruits 50% reported sustaining at least 1 stinger in their career[1]



1. Starr HM Brachial plexus injury: a descriptive study of American football. J Surg Orthop Adv. 2014.
2. Garg R. Comparison of nerve transfers and nerve grafting for traumatic upper plexus palsy: a systematic review and analysis. JBJS 2012.

Virginia Mason Franciscan Health

Nerve Injuries: Stingers

Cervical

- **Typical symptoms: UNILATERAL sensory and motor deficits: sharp pain, ROM ↓, variable motor deficits**

- **RED FLAGS:**
  - Fracture:
    - Neck pain, LOC, AMS change
  - Vascular[1]:
    - HA, dizzy, N/V, AMS, & changes in vision.
    - Stroke symptoms

- **Removed from play & further workup**
  - Any Red flags = immobilization/ER
  - Unilateral UE only symptoms
    - If symptoms persist >5 min
    - >2 stingers in 1 year

1. De Souza RM. Blunt traumatic vertebral artery injury: a clinical review. Eur Spine J. 2011.

Virginia Mason Franciscan Health

Nerve Injuries: Stingers

Cervical

- **Typical symptoms: UNILATERAL sensory and motor deficits: sharp pain, ROM ↓, variable motor deficits**

- **RED FLAGS:**
  - Fracture:
    - Neck pain, LOC, AMS change
  - ***Vascular[1]:***
    - ***HA, dizzy, N/V, AMS, & changes in vision.***
    - ***Stroke symptoms***
- **Removed from play & further workup**
  - Any Red flags = immobilization/ER
  - Unilateral UE only symptoms
    - If symptoms persist >5 min
    - >2 stingers in 1 year

1. De Souza RM. Blunt traumatic vertebral artery injury: a clinical review. Eur Spine J. 2011.

Virginia Mason Franciscan Health

Nerve Injuries: Stingers

Cervical

- **Typical symptoms: UNILATERAL sensory and motor deficits: sharp pain, ROM ↓, variable motor deficits**

- **RED FLAGS:**
  - Fracture:
    - Neck pain, LOC, AMS change
  - Vascular[1]:
    - HA, dizzy, N/V, AMS, & changes in vision.
    - Stroke symptoms

- ***Removed from play & further workup***
  - ***Any Red flags = immobilization/ER***
  - ***Unilateral UE only symptoms***
    - ***If symptoms persist >5 min***
    - ***>2 stingers in 1 year***

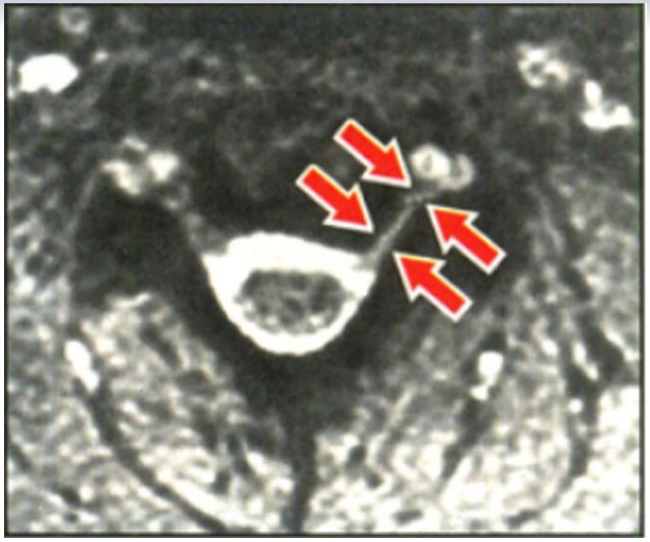
1. De Souza RM. Blunt traumatic vertebral artery injury: a clinical review. Eur Spine J. 2011.

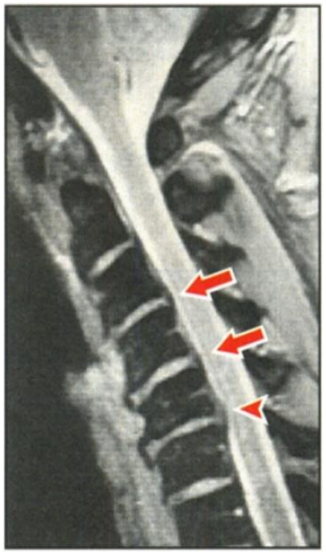
Virginia Mason Franciscan Health

Nerve Injuries: Stingers

Cervical

- **Diagnostics: X-rays/MRI**
  - No consensus
  - NOT INDICATED
    - 1st isolated stinger / symptom resolution within 5 min of injury
  - INDICATED[1]
    - Symptoms >1 h, localize to 1 nerve root, neck pain with normal cervical ROM
    - >2 stinger episodes





- **Diagnostics: EMG**
  - Persistent neuromuscular abnormalities
  - May perform early as 7 days following the onset of symptoms
  - 2 to 4 weeks for axonal degeneration

1. Lewno, A. Stingers and burners. In: Musculoskeletal sports and spine disorders. Springer International Publishing; 2017.

Virginia Mason Franciscan Health

Nerve Injuries: Stingers

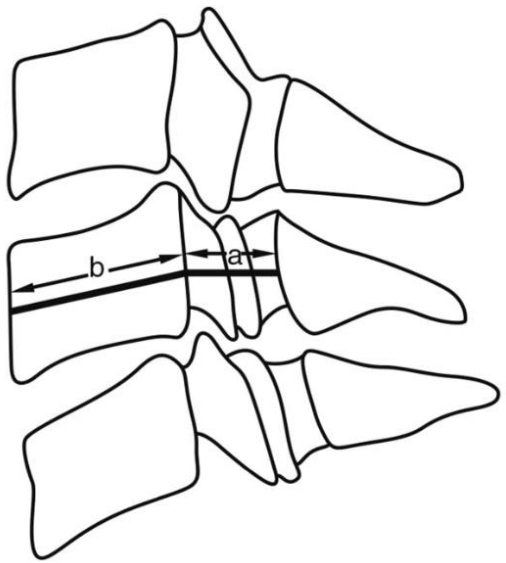
Cervical

The American Journal of Sports Medicine, Vol. 22, No. 2
© 1994 American Orthopaedic Society for Sports Medicine

Cervical Spinal Stenosis and Stingers in Collegiate Football Players*

Scott A. Meyer,† MD, Kary R. Schulte, MD, John J. Callaghan, MD, John P. Albright, MD, John W. Powell, PhD, ATC, Edward T. Crowley, LPT, ATC, and Georges Y. El-Khoury, MD

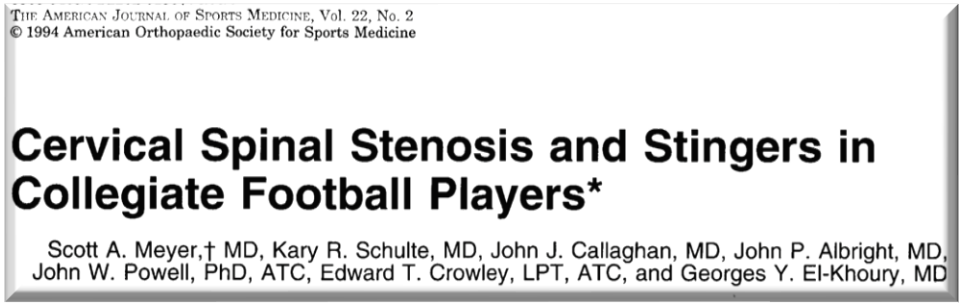
- Radiographic study of 266 college football players
- Torg ratio (a/b) <0.8 had 3X the risk of stingers



Virginia Mason Franciscan Health

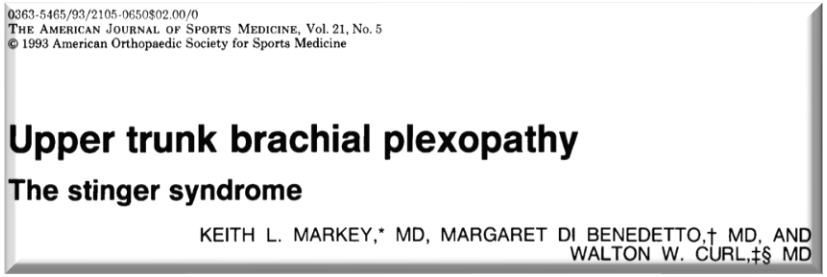
Nerve Injuries: Stingers

Cervical


THE AMERICAN JOURNAL OF SPORTS MEDICINE, Vol. 22, No. 2
© 1994 American Orthopaedic Society for Sports Medicine

Cervical Spinal Stenosis and Stingers in Collegiate Football Players*

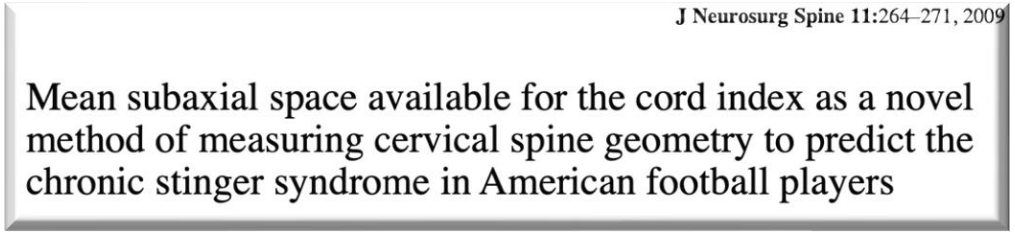
Scott A. Meyer,† MD, Kary R. Schulte, MD, John J. Callaghan, MD, John P. Albright, MD, John W. Powell, PhD, ATC, Edward T. Crowley, LPT, ATC, and Georges Y. El-Khoury, MD


0363-5465/93/2105-0650$02.00/0
THE AMERICAN JOURNAL OF SPORTS MEDICINE, Vol. 21, No. 5
© 1993 American Orthopaedic Society for Sports Medicine

Upper trunk brachial plexopathy

The stinger syndrome

KEITH L. MARKEY,* MD, MARGARET DI BENEDETTO,† MD, AND WALTON W. CURL,‡§ MD


J Neurosurg Spine 11:264–271, 2009

Mean subaxial space available for the cord index as a novel method of measuring cervical spine geometry to predict the chronic stinger syndrome in American football players

- **Controversy: likely describing 2 separate etiologies**
  - Acute Stinger: injury to Brachial Plexus
  - Chronic Stinger: degenerative changes resulting in narrowing of neuroforamen

Virginia Mason Franciscan Health

Nerve Injuries: Stingers

Cervical

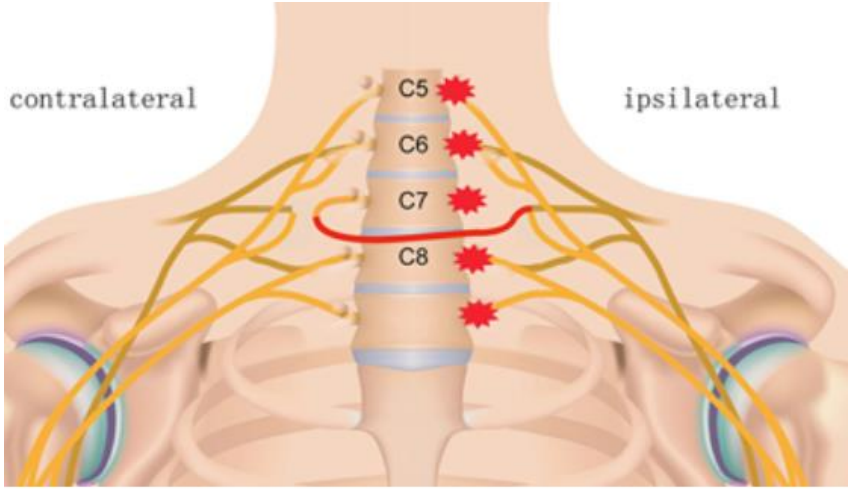
Current Reviews in Musculoskeletal Medicine (2020) 13:651–662
https://doi.org/10.1007/s12178-020-09665-5

HOT TOPICS

The Prevalence and Management of Stingers in College and Professional Collision Athletes

Daniel R. Bowles [1] · Jose A. Canseco [1] · Tyler D. Alexander [1] · Gregory D. Schroeder
Alexander R. Vaccaro [1]

- **Interventional / Operative**
  - Transforaminal ESI
    - Consider >2 stingers
    - Residual sensory symptoms
    - Adjuvant to targeted PT
  - Operative
    - Permanent / residual deficits
    - Most Common Injured: C5/6 (elbow flexion, shoulder ABD / ER)
    - Primary objective: restore mobility of those muscles controlled by the injured nerve
    - Dual nerve transfer favored over traditional nerve grafting



Virginia Mason Franciscan Health

Fractures

Cervical

Virginia Mason Franciscan Health

Catastrophic Cervical Spine Injuries in High School and College Football Players

Barry P. Boden,*† MD, Robin L. Tacchetti,† MS, PT, Robert C. Cantu,‡ MD,
Sarah B. Knowles,§ PhD, and Frederick O. Mueller,§ PhD
From †The Orthopaedic Center, Rockville, Maryland, ‡Emerson Hospital, Concord, Massachusetts, and the §University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

- **Of 196 of HS / College football players with C spine injuries 4.6% involve upper cervical spine**
- **Odontoid fractures MOST COMMON**

Virginia Mason Franciscan Health

Catastrophic Cervical Spine Injuries in High School and College Football Players

Barry P. Boden,*† MD, Robin L. Tacchetti,† MS, PT, Robert C. Cantu,‡ MD,
Sarah B. Knowles,§ PhD, and Frederick O. Mueller,§ PhD
From †The Orthopaedic Center, Rockville, Maryland, ‡Emerson Hospital, Concord, Massachusetts, and the §University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

- **Odontoid fractures**
  - Assess if neurologic deficit
  - Assess Stability: >5 mm displacement or >11 deg angulation
    - Stable: hard collar or halo
    - Unstable: Odontoid screw vs posterior instrumented fusion
    - Controversy: Surgical fixation if not unstable

FRACTURES
CERVICAL

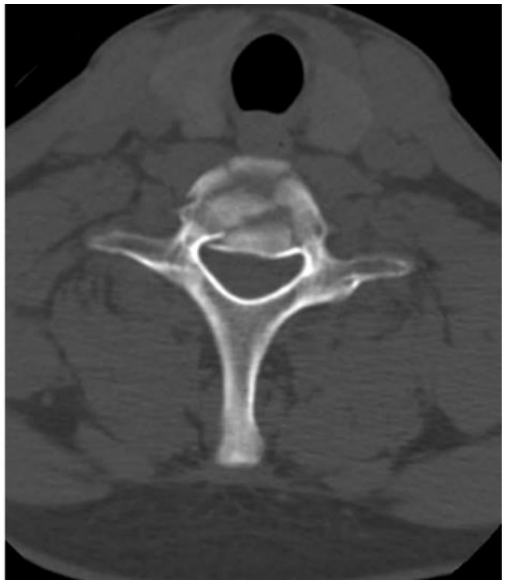
INJURIES TO POSTERIOR TENSION BAND

- **Flexion-compression injury**
  - Tear drop fragment (anterior inferior vertebral body)
- **Most devastating is bilateral facet dislocations**
  - 90% associated SCI
- **Surgical fixation in all athletes with posterior ligamentous complex**

Torg JS. The axial load teardrop fracture: A biomechanical, clinical and roentgenographic analysis. Am J Sports Med 1991.

Virginia Mason Franciscan Health

FRACTURES
CERVICAL



Compression/Burst fractures

- **Axial force across neutral positioned spine**
- **Compression fractures**
  - Anterior column fracture
  - Not associated with neuro injury
- **Burst fractures**
  - Involve posterior vertebral wall
  - Associated with neuro injury

Torg JS. The axial load teardrop fracture: A biomechanical, clinical and roentgenographic analysis. Am J Sports Med 1991.

Virginia Mason Franciscan Health

SPINE Volume 32, Number 21, pp 2365–2374
©2007, Lippincott Williams & Wilkins, Inc.

The Subaxial Cervical Spine Injury Classification System

A Novel Approach to Recognize the Importance of Morphology, Neurology, and Integrity of the Disco-Ligamentous Complex

Alexander R. Vaccaro, MD,* R. John Hulbert, MD,† Alpesh A. Patel, MD,‡
Charles Fisher, MD,§ Marcel Dvorak, MD,§ Ronald A. Lehman, Jr., MD,‖
Paul Anderson, MD,¶ James Harrop, MD,* F. C. Oner, MD, PhD,# Paul Arnold, MD,**
Michael Fehlings, MD, PhD, MD,†† Rune Hedlund, MD,‡‡ Ignacio Madrazo, MD, DSc,§§
Glenn Rechtine, MD,‖‖ Bizhan Aarabi, MD,¶¶ Mike Shainline, MS,## and the
Spine Trauma Study Group

- **Spine Trauma Study Group classification system**
- **Based on information on injury pattern neurologic involvement, treatment considerations, and prognosis**
- **Excellent interrater reliability (93% surgeons agreed with treatment recommendations**

1. Schroeder G. Cervical Spine Injuries in the Athlete. JAAOS 2016.

FRACTURES

CERVICAL

SPINE Volume 32, Number 21, pp 2365–2374
©2007, Lippincott Williams & Wilkins, Inc.

The Subaxial Cervical Spine Injury Classification System

A Novel Approach to Recognize the Importance of Morphology, Neurology, and Integrity of the Disco-Ligamentous Complex

Alexander R. Vaccaro, MD,* R. John Hulbert, MD,† Alpesh A. Patel, MD,‡ Charles Fisher, MD,§ Marcel Dvorak, MD,§ Ronald A. Lehman, Jr., MD,‖ Paul Anderson, MD,¶ James Harrop, MD,* F. C. Oner, MD, PhD,# Paul Arnold, MD,** Michael Fehlings, MD, PhD, MD,†† Rune Hedlund, MD,‡‡ Ignacio Madrazo, MD, DSc,§§ Glenn Rechtine, MD,‖‖ Bizhan Aarabi, MD,¶¶ Mike Shainline, MS,## and the Spine Trauma Study Group

Sub axiaL Injury Classification (SLIC)

- **≤ 3 points:** nonsurgical
- **4 points:** indeterminate
- **≥ 5 points:** surgical

Table 1. SLIC Scale

	Points
Morphology	
No abnormality	0
Compression	1
Burst	+1 = 2
Distraction (*e.g.*, facet perch, hyperextension)	3
Rotation/translation (*e.g.*, facet dislocation, unstable teardrop or advanced staged flexion compression injury)	4
Disco-ligamentous complex (DLC)	
Intact	0
Indeterminate (*e.g.*, isolated interspinous widening, MRI signal change only)	1
Disrupted (*e.g.*, widening of disc space, facet perch or dislocation)	2
Neurological status	
Intact	0
Root injury	1
Complete cord injury	2
Incomplete cord injury	3
Continuous cord compression in setting of neuro deficit (Neuro Modifier)	+1

1. Schroeder G. Cervical Spine Injuries in the Athlete. JAAOS 2016.

Virginia Mason Franciscan Health

FRACTURES
CERVICAL

SPINE Volume 32, Number 21, pp 2365–2374
©2007, Lippincott Williams & Wilkins, Inc.

The Subaxial Cervical Spine Injury Classification System

A Novel Approach to Recognize the Importance of Morphology, Neurology, and Integrity of the Disco-Ligamentous Complex

Alexander R. Vaccaro, MD,* R. John Hulbert, MD,† Alpesh A. Patel, MD,‡ Charles Fisher, MD,§ Marcel Dvorak, MD,§ Ronald A. Lehman, Jr., MD,‖ Paul Anderson, MD,¶ James Harrop, MD,* F. C. Oner, MD, PhD,# Paul Arnold, MD,** Michael Fehlings, MD, PhD, MD,†† Rune Hedlund, MD,‡‡ Ignacio Madrazo, MD, DSc,§§ Glenn Rechtine, MD,‖‖ Bizhan Aarabi, MD,¶¶ Mike Shainline, MS,## and the Spine Trauma Study Group

Table 1. SLIC Scale

	Points
Morphology	
No abnormality	0
Compression	1
Burst	+1 = 2
Distraction (*e.g.*, facet perch, hyperextension)	3
Rotation/translation (*e.g.*, facet dislocation, unstable teardrop or advanced staged flexion compression injury)	4
Disco-ligamentous complex (DLC)	
Intact	0
Indeterminate (*e.g.*, isolated interspinous widening, MRI signal change only)	1
Disrupted (*e.g.*, widening of disc space, facet perch or dislocation)	2
Neurological status	
Intact	0
Root injury	1
Complete cord injury	2
Incomplete cord injury	3
Continuous cord compression in setting of neuro deficit (Neuro Modifier)	+1

Sub axiaL Injury Classification (SLIC)

- **≤ 3 points:** nonsurgical
- **4 points:** indeterminate
- **≥ 5 points:** surgical

1. Schroeder G. Cervical Spine Injuries in the Athlete. JAAOS 2016.

Virginia Mason Franciscan Health

FRACTURES

CERVICAL

SPINE Volume 32, Number 21, pp 2365–2374
©2007, Lippincott Williams & Wilkins, Inc.

The Subaxial Cervical Spine Injury Classification System

A Novel Approach to Recognize the Importance of Morphology, Neurology, and Integrity of the Disco-Ligamentous Complex

Alexander R. Vaccaro, MD,* R. John Hulbert, MD,† Alpesh A. Patel, MD,‡ Charles Fisher, MD,§ Marcel Dvorak, MD,§ Ronald A. Lehman, Jr., MD,‖ Paul Anderson, MD,¶ James Harrop, MD,* F. C. Oner, MD, PhD,# Paul Arnold, MD,** Michael Fehlings, MD, PhD, MD,†† Rune Hedlund, MD,‡‡ Ignacio Madrazo, MD, DSc,§§ Glenn Rechtine, MD,‖‖ Bizhan Aarabi, MD,¶¶ Mike Shainline, MS,## and the Spine Trauma Study Group

Sub axiaL Injury Classification (SLIC)

- **≤ 3 points:** nonsurgical
- **4 points:** indeterminate
- **≥ 5 points:** surgical

Table 1. SLIC Scale

	Points
Morphology	
No abnormality	0
Compression	1
Burst	+1 = 2
Distraction (*e.g.*, facet perch, hyperextension)	3
Rotation/translation (*e.g.*, facet dislocation, unstable teardrop or advanced staged flexion compression injury)	4
Disco-ligamentous complex (DLC)	
Intact	0
Indeterminate (*e.g.*, isolated interspinous widening, MRI signal change only)	1
Disrupted (*e.g.*, widening of disc space, facet perch or dislocation)	2
Neurological status	
Intact	0
Root injury	1
Complete cord injury	2
Incomplete cord injury	3
Continuous cord compression in setting of neuro deficit (Neuro Modifier)	+1

1. Schroeder G. Cervical Spine Injuries in the Athlete. JAAOS 2016.

SPINAL CORD INJURY

CERVICAL

- **RARE**
- **#1: C spine precautions = prevent further injury**

Virginia Mason Franciscan Health

AOSPINE

Guidelines Paper

Global Spine Journal
2017, Vol. 7(3S) 203S-211S
© The Author(s) 2017
Reprints and permission:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/2192568217703085
journals.sagepub.com/home/gsj
SAGE

A Clinical Practice Guideline for the Management of Patients With Acute Spinal Cord Injury: Recommendations on the Use of Methylprednisolone Sodium Succinate

- **Systematic review conclusions**
  - MPSS within 8 hours, 6- and 12-months indicated modest improvements in mean motor scores in the MPSS
- **Recommendations**
  - "We suggest a 24-hour infusion of high-dose MPSS be offered to adult patients within 8 hours of acute SCI as a treatment option"
  - "We suggest not offering a 48-hour infusion of high-dose MPSS to adult patients with acute SCI."

Virginia Mason Franciscan Health

The influence of timing of surgical decompression for acute spinal cord injury: a pooled analysis of individual patient data

www.thelancet.com/neurology Vol 20 February 2021

- 1548 eligible patients from the four datasets, 1 year follow up
- Stratified early (<24 h after spinal injury) & late (≥24 h after spinal injury) decompression groups
- Surgical decompression < 24 h - improved sensorimotor recovery
- Surgical decompression > 36 h - change in total motor score plateaued

Return to play

cervical

Virginia Mason Franciscan Health

RETURN TO PLAY

CERVICAL

RESEARCH—HUMAN—CLINICAL STUDIES

Updated Return-to-Play Recommendations for Collision Athletes After Cervical Spine Injury: A Modified Delphi Consensus Study With the Cervical Spine Research Society

Neurosurgery 87:647–654, 2020 DOI:10.1093/neuros/nyaa308 www.neurosurgery-online.com

General Principle: No athlete can return to play unless he/she is neurologically normal, and have full painless range of motion of the cervical spine.

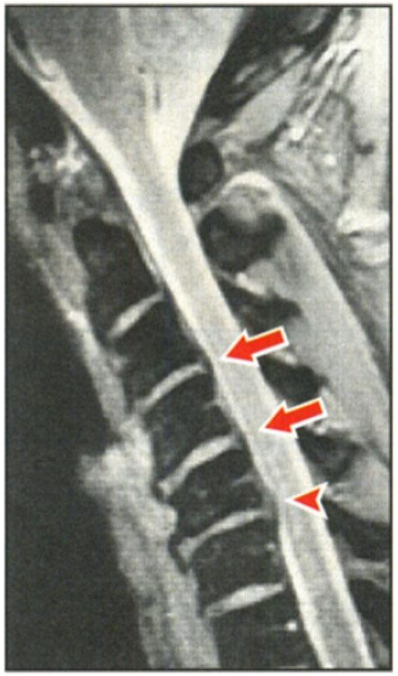
Virginia Mason Franciscan Health

Return to play

Cervical

KEY = MRI

1. **Assess cord signal change**
2. **Assess canal diameter**



Neurosurgery 87:647–654, 2020 DOI:10.1093/neuros/nyaa308 www.neurosurgery-online.com

Virginia Mason Franciscan Health

Return to Play

Cervical

TABLE 2. RTP Guidelines Based on Severity of Cervical Stenosis

Statement	All physicians % (n)	Level of recommendation	% Agreement of professional sports team-affiliated physicians[a] % (n)	*P* value[b]
RTP guidelines in collision athletes based on severity of cervical stenosis				
Following an episode of transient paralysis, asymptomatic athletes with NO T2-signal change and a spinal canal diameter >10 mm are allowed to RTP, but those with a canal diameter <10 mm should be taken on a case-by-case basis.	**Agree: 90.5 (57)** Disagree: 9.5 (6)	Super majority, strong consensus	85.7 (12/14) Strong consensus	.64
Following an episode of transient paralysis, asymptomatic athletes with RESOLVED T2-signal changes and a spinal canal diameter >13 mm are allowed to RTP; those with a canal diameter between 10 and 13 mm should be considered on a case-by-case basis, and those with a canal diameter <10 mm should not RTP.	**Agree: 81.25 (52)** Disagree: 18.75 (12)	Super majority, strong consensus	66.7 (10/15) Weak consensus	.10
Following an episode of transient paralysis, for asymptomatic athletes with CONTINUED T2-signal change and a spinal canal diameter >13 mm RTP should be taken on a case-by-case basis, but those with a canal diameter <13 mm should not RTP.	**Agree: 68.3 (41)** Disagree: 31.7 (19)	Super majority, weak consensus	92.3 (12/13) Strong consensus	.15
Following an injury, for asymptomatic athletes with no history of transient paralysis with CONTINUED T2-signal changes and a spinal canal diameter >13 mm RTP should be taken on a case-by-case basis, but those with canal diameters <13 mm should not RTP.	Agree: 49.3 (33) **Disagree: 50.7 (34)**	Simple majority, no consensus	38.5 (5/13) Weak consensus disagreement	.75

Virginia Mason Franciscan Health

Return to play

cervical

Statement	All physicians % (n)	Level of recommendation	% Agreement of professional sports team-affiliated physicians[a] % (n)	*P* value[b]
RTP guidelines in collision athletes based on severity of cervical stenosis				
Following an episode of transient paralysis, asymptomatic athletes with NO T2-signal change and a spinal canal diameter >10 mm are allowed to RTP, but those with a canal diameter <10 mm should be taken on a case-by-case basis.	**Agree: 90.5 (57)** Disagree: 9.5 (6)	Super majority, strong consensus		
>13 mm RTP should be taken on a case-by-case basis, but those with a canal diameter <13 mm should not RTP.	Disagree: 31.7 (19)			
...owing an injury, for asymptomatic athletes with no history of ...t paralysis with CONTINUED T2-signal changes and a spinal ...er >13 mm RTP should be taken on a case-by-case basis.	Agree: 49.3 (33) Disagree:	Simple majority, no consensus	38.5 (5/13) Weak consensus disagreement	

Virginia Mason Franciscan Health

Return to play

cervical

Statement	All physicians % (n)	Level of recommendation	% Agreement of professional sports team-affiliated physicians[a] % (n)	*P* value[b]
RTP guidelines in collision athletes based on severity of cervical stenosis				
Following an episode of transient paralysis, asymptomatic athletes with RESOLVED T2-signal changes and a spinal canal diameter >13 mm are allowed to RTP; those with a canal diameter between 10 and 13 mm should be considered on a case-by-case basis, and those with a canal diameter <10 mm should not RTP.	**Agree: 81.25 (52)** Disagree: 18.75 (12)	Super majority, strong consensus		
Following an episode of transient paralysis, asymptomatic athletes with CONTINUED T2-signal change and a spinal canal diameter >13 mm RTP should be taken on a case-by-case basis, but those with a canal diameter <13 mm should not RTP.	**Disagree: 68.3 (41)** Agree: 31.7 (19)	Simple majority, no consensus	Strong consensus	
Following an injury, for asymptomatic athletes with no history of transient paralysis with CONTINUED T2-signal changes and a spinal canal diameter >13 mm RTP should be taken on a case-by-case basis,	Agree: 49.3 (33) Disagree:	Simple majority, no consensus	38.5 (5/13) Weak consensus disagreement	

Virginia Mason Franciscan Health

Return to Play

Cervical

TABLE 2. RTP Guidelines Based on Severity of Cervical Stenosis

Statement	All physicians % (n)	Level of recommendation	% Agreement of professional sports team-affiliated physicians[a] % (n)	*P* value[b]
RTP guidelines in collision athletes based on severity of cervical stenosis				
Following an episode of transient paralysis, asymptomatic athletes with NO T2-signal change and a spinal canal diameter >10 mm are allowed to RTP, but those with a canal diameter <10 mm should be taken on a case-by-case basis.	**Agree: 90.5 (57)** Disagree: 9.5 (6)	Super majority, strong consensus	85.7 (12/14) Strong consensus	.64
Following an episode of transient paralysis, asymptomatic athletes with RESOLVED T2-signal changes and a spinal canal diameter >13 mm are allowed to RTP; those with a canal diameter between 10 and 13 mm should be considered on a case-by-case basis, and those with a canal diameter <10 mm should not RTP.	**Agree: 81.25 (52)** Disagree: 18.75 (12)	Super majority, strong consensus	66.7 (10/15) Weak consensus	.10
Following an episode of transient paralysis, for asymptomatic athletes with CONTINUED T2-signal change and a spinal canal diameter >13 mm RTP should be taken on a case-by-case basis, but those with a canal diameter <13 mm should not RTP.	**Agree: 68.3 (41)** Disagree: 31.7 (19)	Super majority, weak consensus	92.3 (12/13) Strong consensus	.15
Following an injury, for asymptomatic athletes with no history of transient paralysis with CONTINUED T2-signal changes and a spinal canal diameter >13 mm RTP should be taken on a case-by-case basis, but those with canal diameters <13 mm should not RTP.	Agree: 49.3 (33) **Disagree: 50.7 (34)**	Simple majority, no consensus	38.5 (5/13) Weak consensus disagreement	.75

Virginia Mason Franciscan Health

Return to play

cervical

	All physicians % (n)	Level of recommendation	% Agreement of professional sports team-affiliated physicians[a] % (n)
Asymptomatic athletes with NO T2-signal change after a solid 1-/2-level ACDF are allowed to RTP, but a 3-level ACDF should not RTP.	**Agree: 84.4 (65)** Disagree: 15.6 (12)		Super majority, strong consensus
Asymptomatic athletes with CONTINUED T2-signal change after a solid 2-/3-level ACDF should not RTP, but a 1-level ACDF should be taken on a case-by-case basis.	**Agree: 81.9 (59)** Disagree: 18.1 (13)		Super majority, strong consensus
with CONTINUED T2-signal change and a spinal canal diameter >13 mm RTP should be taken on a case-by-case basis, but those with a spinal diameter <13 mm should not RTP.	**68.3 (41)** Disagree: 31.7 (19)	consensus	Strong consensus
...ving an injury, for asymptomatic athletes with no history of ...paralysis with CONTINUED T2-signal changes and a spinal ...>13 mm RTP should be taken on a case-by-case basis.	Agree: 49.3 (33) Disagree	Simple majority, no consensus	38.5 (5/13) Weak consensus disagreement

Virginia Mason Franciscan Health

Return to play

cervical

	All physicians % (n)	Level of recommendation	% Agreement of professional sports team-affiliated physicians[a] % (n)
Asymptomatic athletes with a solid fusion after a compression fracture, burst fracture, or facet fracture with no instability and no T2-signal change are allowed to RTP.	**Agree: 98.6 (72)** Disagree: 1.4 (1)	Super majority, strong consensus	
Following an episode of transient paralysis, for asymptomatic athletes with CONTINUED T2-signal change and a spinal canal diameter >13 mm RTP should be taken on a case-by-case basis, but those with a canal diameter <13 mm should not RTP.	**Agree: 68.3 (41)** Disagree: 31.7 (19)	Super majority, weak consensus	92.3 (12/13) Strong consensus
Following an injury, for asymptomatic athletes with no history of transient paralysis with CONTINUED T2-signal changes and a spinal canal diameter >13 mm RTP should be taken on a case-by-case basis,	Agree: 49.3 (33) Disagree	Simple majority, no consensus	38.5 (5/13) Weak consensus

Virginia Mason Franciscan Health

Return to Play

Cervical

Athletes with prior nonoperative or operative treatment for cervical spinal pathology (with the exception of a stinger) should undergo a screening MRI prior to playing a competitive collision/contact sports.	**Agree: 78.9 (45)** Disagree: 21.1 (12)	Super majority, strong consensus

Return to play

cervical

Athletes who are asymptomatic for <5 min following a stinger are allowed to RTP, but for those with symptoms lasting >5 min RTP should be taken on a case-by-case basis.

Virginia Mason Franciscan Health

Take Home Points

- **Spine Injuries in athletics are common**
- **Beware of RED FLAGS – Strict spine precautions**
  - LOC and/or AMS, change in vision
  - Bilateral arm pain
  - Unilateral arm pain >5 min, >2 episodes in 1 year
- **Stingers**
  - Majority <5 min in duration
  - Further evaluation >1 hr or recurrent
- **Fractures**
  - Odontoid is Most Common, typically treated non-op
  - SLIC classification – watch MOI, DCLI, Neuro status
- **SCI**
  - No consensus on steroids, consider if <8 h
  - Early surgical decompression (<24h) improves motor outcomes
- **RTP**
  - Consideration on T2 changes and canal diameter (<10 mm)
  - 1-2 level fusion with solid arthrodesis/asymptomatic may RTP, No RTP in 3 level ACDF
  - If stinger <5 min RTP if >5 min further consideration is warranted

Virginia Mason Franciscan Health

Take Home Points

- **Spine Injuries in athletics are common**
- **Beware of RED FLAGS – Strict spine precauti**
  - LOC and/or AMS, change in vision
  - Bilateral arm pain
  - Unilateral arm pain >5 min
- **Stingers**
  - Majority
  - Fu
- **Fracture**
  - Odo
  - SLIC c
- **SCI**
  - No conse
  - Early surg outcomes
- **RTP**
  - Considerati canal diameter (<10 mm)
  - 1-2 level fusio hrodesis/asymptomatic may RTP, No RTP in 3 level ACDF
  - If stinger <5 mi >5 min further consideration is warranted

LEVEL IV-V EVIDENCE

Virginia Mason Franciscan Health

Thank You

Virginia Mason Franciscan Health