A Pain In The Neck: Sports Related Cervical Spine Conditions

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Disclosures

• Nothing to disclose

• No off label usage
Learning objectives

• Describe the major differential diagnoses associated with cervical spine pain

• Describe evaluation and treatment principles specific to these conditions

• Be able to evaluate the athlete with a cervical spine injury and describe treatment essentials for the seriously injured athlete

• Delineate return to play criteria for various sports related cervical spine injuries and conditions
Epidemiology

• ~10,000 cases of cervical spinal injuries documented in the U.S. annually
• ~10% occur during athletic event
• 2nd leading cause of SCI in first three decades of life
• Comprise 2-3% of all sports-related injuries
• Majority occur during “unsupervised” sports-related activities: diving, skiing, “sand-lot” games
Epidemiology

• In absolute numbers, **recreational diving** is leading cause SCI leading to quadriplegia-alcohol, diving height/water depth, pike diving (Maroon et al *Spine* 1996)

• More public attention given to those injuries that occur during **organized** and/or **televised** competition- American football, wrestling, rugby, hockey, gymnastics, equestrian...
High-Risk Sports

- Football (USA)
- Gymnastics (USA)
- Wrestling (USA)
- Rugby (Europe)
- Ice Hockey (Canada)

- Snow sports
- Cycling
- Equestrian

Kim et al. *Current Opinion Ortho*
2003
Cervical Spine Injury and Football

- Most high-profile group of athletes
- 1.2 million high-school and 200,000 college and pro football players annually.
- Incidence of C-spine injury estimated as high as 10-15% (Meyer AJSM 1994)
- 684 deaths in amateur/pro football 1945-1994, 17% related to cervical spine injury
Ice Hockey and Cervical Spine Injury

- Canada: 258 CSI between 1943 and 2005
- 65% involve contact with boards
- 35% check from behind
- Since 2001, cervical spine injuries from hockey have decreased 69% following rule change/penalty increase for checking from behind, boarding (Tator, CJS, 2009)
Normal Cervical Spine Anatomy

- 7 cervical vertebrae (C1-C7).
- 8 pairs of spinal nerves
- Nerves exit **above** each vertebrae (C6 nerve exits between C5/6)
- Normal cervical **lordosis** – dissipates force
- Normal **bifid** spinous processes
Cervical myotomes

• **C5**: Biceps, deltoid
• **C6**: Wrist extensors
• **C7**: Triceps
• **C8, T1**: Interossei
Cervical Dermatomes

Note: Schematic demarcation of dermatomes (according to Keegan and Garrett) shown as distinct segments. There is actually considerable overlap between adjacent dermatomes. An alternative dermatome map is provided online.
Cervical Spine Injury and Sports

• Broad spectrum of injuries-structural and/or neural

• Vast majority are self-limiting and not catastrophic

• Inverse relationship to frequency of injury and severity (Thomas AAOS 1999)

• Several defined clinical entities....
Clinical Syndromes

- I- Root and Brachial Plexus Neurapraxia
- II- Acute cervical strain
- III- Intervertebral Disc Lesion
- IV- Transient Quadriplegia
- V- Cervical Fractures and Dislocations
I. Root/Plexus Neurapraxia

- “Stunning” of the nerve; disorder of the peripheral nervous system in which there is a temporary loss of motor and sensory function due to blockage of nerve conduction

- Frequently referred to as “burners” or “stingers”

- Most common cervical spine injury in football—up to 65% of all college FB players during 4-year career (Levitz, *AJSM*, 1997)

Stingers

- Can be due to injury to brachial plexus (acute) or cervical root (chronic)
- Subjective findings include acute severe burning pain and paresthesia radiating from neck to ipsilateral arm and fingers
- May c/o “dead arm” with transient muscle paresis
- Self-limited, pain and paresthesia usually resolve within seconds to minutes to 24 hrs
Objective Findings

• C-spine Range of Motion should be full and pain-free
• No tenderness to palpation or deformity
• May see variable decrease in sensation in one or more dermatomes as well as some transient weakness on exam.
• MUST DO COMPLETE NEURO EXAM
• x-rays usually not necessary unless persistent pain or if bilateral
Mechanism of Injury

• Neurapraxia arising from compression or traction on multiple nerve roots or to brachial plexus

• Upper Trunk of the Plexus tensioned by *shoulder depression* with *lateral head flexion* toward opposite side.

• Neural foramen narrows with *concomitant head rotation* toward the affected side.

• Direct blow at *Erbs point*, compressing brachial plexus between superior medial clavicle
CSF Reserve

- 93% of athletes with burners in one study had **cervical djd and neural foramen narrowing** (Levitz, AJSM, 1997)

- NFL Combine: **Less CSF reserve** in those who had chronic burners/stingers (Presciutti, J Neurosurg Spine, 2009)
Treatment and Prevention

• Neck strengthening, cervico-thoracic stablity

• Proper technique: “see what you hit”

• Well-fitting shoulder pads

• Total contact neck-shoulder-chest orthosis, “Cowboy Collar,” U-shaped neck pads-no documented efficacy
II. Acute Cervical Strain

- Injury to the ligamentous structures of the cervical spine
- Some potential for instability
- Typically a direct collision producing hyperflexion or -extension
- Pain localized to neck, not radiating into arms
- Painful range of motion of the C-spine
Cervical Strain/Sprain

- Strain: overload injury to musculotendinous tissues
- Sprain: tear of spinal ligaments
Cervical Sprain/Strain

Cervical “tension myalgia”; myofascial pain

- Suboptimal posture (forward neck flexion and shoulder protraction) contribute

- “Cumulative microtrauma” to cervical paraspinal muscles, traps from overload, unbalanced load

- Risk factors: suboptimal positioning, i.e. road cycling, poor aerobic base/deconditioning
Objective Findings

• Reproducible pain with palpation in the paraspinous soft tissues.

• No deformity or step-off which would suggest more urgent problem

• No neuro deficit on careful exam

• Pain with ROM and focal TTP over spinous process or interspinous ligament after acute injury should be immobilized in rigid C-collar until imaging can be obtained
Evaluation

- Initial Radiographs- A/P, Lateral, odontoid (remember to see T-1)
- Keep in C-collar until acute symptoms subside (7-10 days), then Flex-Ex to r/o instability (F/E acutely may miss due to spasm)
- If continued TTP or painful ROM, consider MRI or CT
- CT: sagittal plane >3.5mm or rotation > 20%=instability
Ligamentous Instability

- > 3.5 mm horizontal displacement
- > 11 degree rotation
- Absolute Contraindication
Treatment

- **Hard cervical collar during acute period**
- **Activity modification, analgesics**
- **Rehabilitation:** include initial midline isometrics, followed by concentric resistance, allowing gradually increasing pain-free arc of motion and progressing to **cervico-thoracic stabilization**
- **Avoid stretching during acute phase (72 hrs)**
III. Intervertebral Disk

- Acute traumatic disc herniation can lead to central cord compression and myelopathy or if lateral, can cause radiculopathy

- Symptoms range from upper extremity radiculopathy to myelopathy with weakness and loss of sensory in all extremities, reflex changes, bowel/bladder changes
Upper Motor Neuron Injury vs Lower Motor Neuron Injury

**UMN:** Spastic paralysis/paresis
- Increased reflexes
- Mild atrophy
- Positive Babinski sign
Signs may appear over *days to weeks*

**LMN:** Flaccid paralysis/paresis
- Decreased reflexes
- Significant atrophy
- Negative Babinski sign
Signs may appear *relatively quickly*
Cervical Radiculopathy

- **Disk herniation** most common
  Hunt, Clin Neuroradiology, 1986

- **Spondylitic changes** second
  Yu, 1987

- **MRI studies** with large number of asymptomatic cervical disk abnormalities
  Boden, JBJS, 1990

- Data suggest **inflammatory response** triggering sns, sxs

- Most common levels: **C7, C6, C8, C5**
Cervical Radiculopathy

- Cervical spondylosis: ligamentous hypertrophy, bony hypertrophy, disk degeneration, zygapophyseal joint disease

- ZA, uncovertebral joint hypertrophy causes foraminal stenosis
  Slipman, 2001

- Vertebral osteophytes and disk material: form “hard disk”
  Radharkrishan, Brain, 1994
Evaluation

- Detailed History- mechanism of injury, pre-existing symptoms, neurologic review of systems
- Document motor, sensory and reflexes.
- C-spine x-rays
- MRI or CT-myelogram to evaluate the amount of cord and/or nerve root compression, especially with severe or progressive neuro deficit or bilateral symptoms
• Often will have **early spondylosis**-narrowed disc space, uncovertebral joint and facet hypertrophy, asymptomatic disc bulges: 75% of freshman football players (Thomas JAAOS 1999)
Treatment

• Usually non-surgical management

• Therapy: modalities, activity modification; oral steroids or epidural steroid injection if pain severe and refractory to rehabilitation interventions

• If progressive neuro deficit or uncontrolled pain, surgery is option, though one year outcome similar to non-op

• ACDF usually surgery of choice for one-two level disease
IV. Transient Quadriplegia

- Described by Torg and others
- Described clinical entity of “neurapraxia of the cervical cord”
- Symptoms include bilateral burning pain, tingling, and loss sensation in arms and/or legs
- Varies from mild weakness to complete paralysis
- Transient- 10 minutes to 48 hours
- During 1984 NCAA season reported in 1.3/10,000 players
Mechanism of Injury

- Axial load with hyperextension or hyperflexion
- Transient cord compression via *Pincer Mechanism* (Penning *Neurology* 1962)
Pavlov, Torg, and the Ratio...

- Pavlov et al devised an objective measurement to determine if patients had congenital cervical stenosis.

- Spinal canal-vertebral body ratio- the distance from midpoint of posterior vertebral body to the nearest point on spinolaminar line \((a)\) divided by A/P width of vertebral body \((b)\)

\[
\text{ratio} = \frac{a}{b}
\]
Torg Ratio and Transient Quadriplegia

- Torg et al in JBJS 1996 described relationship of a Pavlov ratio $<0.8$ (congenital stenosis) and Transient Neurapraxia in college football players.

- 93% sensitivity in players with at least one episode of TQ.

- Low positive predictive value: $<0.8$ only 12-33% of those who will have low functional csf reserve on MRI.
Torg Ratio and its Role

- Very sensitive - the players with TQ will most likely have Torg Ratio of <0.8
- Low specificity - many football players will have a ratio of <0.8 (41% asymptomatic college players)
- Football players likely to have larger vertebral bodies (Herzog Spine 1991)
- Low positive predictive value - value of <0.8 not more likely to suffer catastrophic neurologic injury
- Therefore, x-ray screening using Torg ratio is not recommended
MRI Documented CSF Functional Reserve

- Most sensitive
- CSF (functional) reserve = disk level spinal canal diameter minus spinal cord diameter as seen on MRI T2 images
V. Cervical Fractures and Dislocations

• Most athletes with permanent spinal cord injuries have unstable fractures/dislocations

• No direct relationship b/w canal geometry and risk of SCI (Torg 1986)

• Incidence of head injury decreased in the 1960-70’s while catastrophic SCI rose

• Incidence of fx/dislocations up 204% with perm. SCI up 116%- related to new/better helmets and dangerous tackling behavior. (Schneider et al 1964)
Axial load, Spear Tackling, and Mechanics of Fracture

• **Axial loading** of the cervical spine is the prime mechanism

• C-spine can absorb energy of collision by dissipating through paraspinal muscles, the disc, and the normal lordotic curve

• When neck flexed 30 degrees, as in spear tackling, forces transmitted along longitudinal axis of spine

• Compression of disc, angular deformation, failure in flexion with fracture, sublux/dislocation
Spear Tackler’s Spine

Figure 11. Spear tackler’s spine involves loss of normal cervical lordosis. When subjected to an axial loading force, the straightened cervical spine behaves like a segmented column. The force first compresses the intervertebral discs (a and b). As maximum compression is reached, the spine flexes and buckles (c) with resulting fracture, subluxation, or dislocation (d and e). The combination of spear tackler’s spine and head-first tackling is extremely dangerous.
Torg’s “Caveat”- spear-tackler’s spine

- Torg described a subset of this population with a constellation of radiographic findings
  - Ratio of $<0.8$
  - loss of normal cervical lordosis-straight spine
  - post-traumatic degenerative disease

- Combined with propensity to spear tackle, creates high likelihood of neuro injury and CONTRAINDICATION to play
19 yo college linebacker with video documentation of spear-tackling, shows "spear-tackler’s spine"--taken 1 week prior to being rendered quadriplegic following tackle. (Med Sci Sport Exerc 1997)
The benefits of the research...

• As a result of detailed analysis of data on rates of C-spine injury, NCAA in 1976 banned spear-tackling.

• Dramatic reduction in fracture/dislocation and SCI—overall approx. 70% in high-school and college football (Torg JBJS 2002)
Field Evaluation and Initial Treatment

• Initial treatment often begins on the field/rink

• Essential sideline equipment- spine board, stretcher, tools for removing mask from helmet (bolt-cutter, utility knife; newer helmets with release latch-Riddell, Schutt)

• If unconscious player, protect airway while protecting the c-spine- leave helmet on, jaw thrust and chin-lift, not head tilt
• Neck pain, focal midline tenderness (on spinous processes or interspinous ligaments), painful/limited neck ROM, or neurologic signs/symptoms needs to be immobilized and transported to ED.

• Immobilize on spine board, helmet and pads on.

• Remove only when in controlled setting, pull off in line with spine. Can change alignment if done incorrectly! (CJSM 2003)

• If needed, get films with gear in place
Helmet and Pads On… or Off?

- Second Inter-Association Task Force on the Prehospital Care of the Suspected Spine Injured Athlete, Jan 2015; 24 medical organizations

- “When deemed necessary by onsite medical personnel, protective equipment *may* be removed prior to transport.”

Helmet & pads, airway access, facilitate ER & hospital management

- Limitations: facemask removal often enough, less cervical motion, less personnel required
Summary: On-field C-spine management

• Assume SCI
• ABCs, activate EMS
• Minimize movement (only move for ABCs or to make supine)
• Move head and trunk as a unit
• Remove facemask before transport for access
• Preparation and practice, practice, practice are key
Imaging evaluation of c-spine injury

- Flexion-extension X-rays:
  
  30-70% are inadequate to show instability in the setting of acute injury, due to muscle spasm and pain

- CT:
  
  Instability criteria: Sagittal plane translation > 3.5 mm or 20%, or sagittal plane rotation > 20 degrees
Timing of Return to Play After Cervical Spine Injury

• Sideline evaluation often difficult - fans, coaches, teammates,

• Need to clearly define serious from minor injury before decision to return to play
Guidelines for Return to Play

• I. Stingers-
  • May return to play when paresthesias resolve, full strength and painless ROM demonstrated
  • No data on how many is “too many”
II. Acute Cervical Strain

- Need to immobilize and get x-rays if focal tenderness, decreased ROM, hx prior surgery
- When pain-free, get flex-ex views; CT, MRI helpful if persistent pain
- If F/E normal, return to play when neck ROM painless
- Proper rehab key, cervico-thoracic stabilization
III. Intervertebral disc

- Potential for more serious neurologic sequela
- When radicular symptoms resolved, full pain-free ROM, NL strength and cervico-thoracic stability: may return to sport
- If ACDF required of one level, may return once fusion solid and painless ROM, if no adjacent segment disease (Torg CJSM 1997)
- Two level relative contraindication, 3 levels absolute contraindication
IV. Transient Quadriplegia

• Torg et al guidelines (Med Sci Sport Excer 1997)
  • Pavlov ratio of <0.8 in asymptomatic player no contraindications to play
  • Developmental stenosis with one episode cord neurapraxia, relative contraindication
  • Documented episode associated with cervical spondylosis or disc disease- relative contraindication
  • Documented episode with MRI evidence of cord edema- relative/absolute contraindication
  • Documented episode with radiographic instability, neuro symptoms >36 hours, and/or multiple episodes-ABSOLUTE CONTRAINDICATION
IV Transient Quadriplegia

Absolute contraindications for return to play after an episode of TQ

- Persistent neurological findings, cervical pain, or loss of ROM
- MRI evidence of spinal cord defect or edema
- Functional spinal stenosis on MRI
- Acute cervical fracture or ligamentous disruption
- Acute or chronic cervical disc herniation
- Cervical spine segmental instability
- Arnold-Chiari malformation
- Basilar invagilation, os odontoideum
- Atlanto-occipital fusion or instability
- Klippel-Feil fusion greater than two levels
- Multi level surgical fusion

V. Fractures and Instability

• Upper C- spine
  
  **Atlantoaxial Instability** - traumatic instability
  poor prognosis, obvious absolute contraindication to collision activities
  
  X-rays: **Atlanto-odontoid distance > 3-4mm**
  
  • **Down’s Syndrome**: 10-20% AA instability, 1-2% symptomatic
  
  Sx: consider surgical eval, no sports
  Asx: certain restrictions (alpine skiing, gymnastics, equestrian, diving, soccer)
  
  Screening x-rays: controversial (poor correlation between XR & symptoms)
C1: Jefferson Fracture

- Burst fracture of C1
- Occipital condyles driven into lateral masses of C1; 2-4 part fracture, A & P arches
- Common mechanism: head first **dive into shallow water**
- Normally no neuro deficit unless fragment retropulsed
- P arch alone: hard collar, SOMI; if transverse ligament tear, Halo or Sx
- Unstable if > 7mm displacement
C2 fractures: Hangman’s Fracture

Hyperextension fractures pedicles, then secondary flexion + Distraction (tears PLL) = bilateral fractures thru pedicles of axis with anterior dislocation of body

Type 1: Rigid collar
Type 2 and 2A: Halo vs surgery
Type 3: Surgery

Levine and Edwards classification
Odontoid fractures

- Type 1: avulsion of tip-stable
- Type 2: fracture of base-usually surgery
- Type 3: fracture of body-usually surgery
Clay Shoveler’s Fracture

- C7 spinous process fx
- Hyperflexion injury
- No neurologic deficit
- Stable spine
Fractures

- No contraindication
  - healed **stable compression fracture of body** with normal alignment and no instability
  - healed **endplate fracture**
  - healed **spinous process fracture** (clay shoveler’s)

- Relative contraindication
  - healed **depressed compression fracture** (wedge) with painless ROM
  - Healed **posterior element fracture** with painless ROM
  - Healed **Jefferson fx (C1)**, type I and II odontoid, lateral mass of C2
Fractures

• Absolute contraindication
  • any acute cervical fracture
  • vertebral body fracture with sagittal component to fracture
  • any body fracture which involves the posterior elements
  • any fracture with retropulsion into canal
  • any healed fracture with continued pain, limited ROM, or neurologic findings
Klippel-Feil syndrome

• Congenital fusion of any 2 of the 7 cervical vertebrae

• Type 1: single fused segment

• Type 2: multiple fused segments, nonadjacent

• Type 3: multiple fused segments, adjacent

• X-rays: assess instability

• Asymptomatic: restrict from contact/collision if Type 2 or Type 3 above C3

• Symptomatic: surgical evaluation
Thank You!
Selected References

Selected References


