cervical spine sports injuries
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Well more than half of catastrophic injuries in sports are cervical spine injuries.

Injuries occur in most contact sports, including football, hockey, rugby, and wrestling.

Non-contact sports are not excluded: skiing, track and field, diving, surfing, power lifting, and equestrian events.

C-spine injuries are estimated to occur in 10-15% of all football players.
- Linemen and defensive players
- Serious injuries with neurologic sequelae remain infrequent.
  - Most of these injuries are self-limited
- Amateur and weekend athletes are at risk too.

Football and rugby have the highest incidences of C-spine injuries among ALL sports.
- High-speed collisions between players, causing acceleration or deceleration of the head on the neck, lead to injuries.
- Acceleration results in extension forces.
- Deceleration results in flexion forces.

Spearing
- Banned since 1976, spearing occurs when a player uses the helmet/head as the first point of contact with another player (head down tackling).
- Spearing is a significant cause of C-spine injuries and quadriplegia.
- The force transmitted to the cervical spine in these cases is one of axial compression with the vertebrae in positions of slight flexion.
- https://www.youtube.com/watch?v=xJhvBpHloBQ

The cervical lordosis allows for controlled motion and the transmission of forces to the supporting muscles and soft tissues.
- When the neck is slightly flexed, approximately 30°, the normal lordosis is straightened, and the forces of the axial load are transmitted to the bones and disks.
- If the impact force is greater than the yield strength of the vertebrae, a fracture and possible dislocation with cord injury can occur.
Categories of C-Spine Injuries

- Sports-related cervical spine injuries are most commonly:
  - Nerve root or brachial plexus injuries
  - Acute cervical sprains/strains
  - Intervertebral disk injuries
  - Cervical fractures and dislocations
  - Cervical stenosis

Nerve Root/Brachial Plexus Injuries

- The most common cervical injury in football players is the transient loss of function with searing or lancing pain down one arm following a collision
  - AKA: stingers or burners
- Early symptoms are total arm weakness and a radiating burning sensation that usually eventually resolves
- Numbness in the C6 dermatomal distribution may persist
- Motor weakness of shoulder abductors, elbow flexors, external humeral rotators, and wrist and finger extensors may persist
- The duration of symptoms is from 2-10 minutes to 24 hours
- Symptoms are reproduced by the Spurling maneuver
- Function gradually returns from the proximal muscle groups to the distal muscle groups

Injury Severity

- Neuropraxia is a selective demyelination of the nerve sheath, and it is the most benign injury
- Axonotmesis is a disruption of the axon and the myelin sheath, but the epineurium is intact
- The most severe injury is a neurotmesis or a compete disruption of the endoneurium
Differentials

- The differential diagnoses of burners include acute cervical disk herniations, foraminal stenosis, and extradural intraspinal masses.
- Stingers may be the result of:
  - A distraction or stretch injury in which the head is driven to the side opposite the painful arm and the ipsilateral shoulder is depressed. This causes a momentary stretch injury to the upper cords of the brachial plexus.
  - The extended C-spine is compressed and rotated toward the painful arm. Injury occurs because the cervical nerves are tethered by fibrous tissue between the vertebral arteries and the distal foramina at each cervical level. These dentate ligament attachments become taut and stretch the cervical nerve roots as they leave the spine.

Treatment

- Because most burners are self-limited, the most important step is to evaluate the possibility an unstable cervical injury.
  - The key to assessment is that patients with burners have full pain-free neck range of motion (ROM).
  - If neck motion is decreased or painful, withdraw the athlete from play and obtain cervical radiographs to rule out fracture/dislocation.
  - If symptoms persist for 3-4 weeks following injury, obtain an electromyogram (EMG) to evaluate upper trunk function.

Acute Cervical Sprains/Strains

- An athlete with a sprain or strain usually presents after jamming his/her neck.
  - The pain is localized to the C-spine and limits cervical ROM.
  - Pain and paresthesias do not radiate to the arms.
  - The neural examination is normal, and radiographs are negative for evidence of fracture or dislocation.

Acute Disk Herniations

- Acute disk herniations in football are rare.
  - However, with acute onset of transient neurological deficits and negative cervical radiographs, we must consider a ruptured cervical disk as a cause.

- Symptoms of herniation vary from radiculopathy to anterior cord syndrome.
  - Anterior cord syndrome occurs with an acute paralysis of the upper, lower, or all 4 extremities.
  - An associated loss of pain and temperature sensation to the level of the lesion occurs.
  - The posterior column vibratory, proprioceptive, and light touch sensations are preserved.
Chronic Disk Changes

- In contrast to the rare nature of acute disk herniations in contact sports, disk injuries without frank herniation or neurologic injury can be common and are characterized by chronic changes.
- Chronic disk changes frequently are seen in athletes who compete in contact sports.

- Albright studied cervical spine radiographs of 75 University of Iowa freshmen football recruits.
- Radiographs taken at end of high school but before college seasons.
- Albright found that 32% had 1 or more of the following conditions:
  - Occult fracture
  - Vertebral compression fracture
  - Disk space narrowing
  - Osteophytes and degenerative changes

Cervical Fractures and Dislocations

- Albright’s findings illustrate that the constant loading of the C-spine in contact sports leads to chronic degeneration.
- MRI scans of patients with chronic disk injuries reveal a disk bulge with no obvious herniation.

- Cervical fractures and dislocations occur when the axial loading forces applied to the C-spine are greater than the yield strength of the vertebral bodies or the supporting ligamentous structures.
- Many forms exist, including the following:
  - Subluxation without fracture, with or without neurologic injury
  - Dislocations, with or without neurologic injury
  - Fractures, with or without neurologic injury

- The most important consideration when discussing cervical fractures and dislocations is the concept of stability.
- Stability (White and Panjabi) is the ability of the spine to limit its patterns of displacement during physiologic loads to prevent damage or irritation to the spinal cord and nerve roots.

- Instability of the adult spine therefore is defined as dysfunction of the posterior elements with more than 3.5 mm displacement (or >20% translation) in the horizontal sagittal plane.
• Instability is also apparent by analyzing the angular measurements between motion segments
• Greater than 20° of sagittal plane rotation on flexion/extension films is considered abnormal and potentially unstable
• In the acute setting where flexion/extension radiographs are not obtainable, greater than 11° of relative sagittal plane angulation between cervical motion segments on a static lateral C-spine radiograph is considered unstable

• Dislocation without fracture results from disruption of the posterior soft tissue supporting elements
• Angulation and anterior translation of the superior vertebrae occurs
• No associated fractures exist and associated neurologic injuries may or may not exist
• The diagnosis is made by flexion/extension lateral C-spine radiographs, which show active motion, anterior intervertebral disk space narrowing, and fanning of the spinous processes posteriorly

• White and Panjabi Clinical Checklist

  In 1990, White and Panjabi described a formula for evaluating fracture stability. Under normal physiological conditions, cervical spine movements are smooth, effortless, pain-free, and do not produce neurological symptoms. Two fundamental structures of cervical motion segments facilitate abnormal kinematics: discoligamentous complex and the articulating facet joints.

  White and Panjabi’s extensive biomechanical investigations reproduced the share of each motion segment in maintaining stability. Based on these cadaveric experiments, ALL and PLL best maintained the stability of the anterior element, and joint capsules and the anatomy of facets were most important in maintaining posterior stability.

  The stability check list introduced by White and Panjabi was based on these studies. One should consider the fact that White and Panjabi’s checklist was based on radiographs, before the widespread use of CT and MRI. Similarly, some maneuvers, such as stretch testing or dynamic studies, may not be compatible with the present standards of cervical spine clearance in patients with traumatic brain or cervical spine injuries.

  Nonetheless, many of the principles for determining stability upon which the checklist is built remain widely utilized in clinical practice today, albeit in a less formal manner. The checklist has never been validated nor its reliability measured.

White and Panjabi Instability Scale

<table>
<thead>
<tr>
<th>TABLE 1: Stability Checklist as Suggested by White and Panjabi*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic Checklist Elements</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Vertebrae elements destroyed or unable to function</td>
</tr>
<tr>
<td>Vertebrae elements displaced or unable to function</td>
</tr>
<tr>
<td>Relative sagittal plane translation &gt;15 mm</td>
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<tr>
<td>Relative sagittal plane rotation &gt;11 degrees</td>
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<tr>
<td>Relative spinous process translation &gt;10%</td>
</tr>
<tr>
<td>Ruptured ligament</td>
</tr>
<tr>
<td>Neurologic damage</td>
</tr>
<tr>
<td>Neurovascular injury</td>
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<tr>
<td>Serious neurologic deficit anticipated</td>
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</tbody>
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*Any of 1 points or more = unstable = a translation >25% of the anteroposterior diameter of the affected vertebrae

- The prognosis in patients with subluxation without fracture depends on the degree of displacement
- Instability is likely despite nonoperative treatment, and if anterior subluxation is more than 20% of the vertebral body width, treatment should be posterior cervical fusion

Atlas Fractures

- C1 or atlas fractures usually result from axial loading and are decompressive fractures that rarely result in neurologic deficits

- Anterior arch fractures
- Posterior arch fractures
- Lateral mass fractures
- Jefferson (burst) fractures

Jefferson’s Burst Fracture
Odontoid Fractures

- These fractures usually are secondary to hyperextension, flexion, or rotational forces.
- The overall union rate of type II fractures is 68% with halo treatment.
- Type II odontoid fractures with more than 10° of angulation or more than 5 mm of translation should be treated with surgery rather than a halo to decrease the pseudoarthrosis rate.
- Nonunions can be common among type II odontoid fractures.
  - Age older than 50 years
  - Displacement of more than 5 mm
  - Posterior versus anterior displacement
  - Excessive halo vest treatment
Axis Fractures

- Traumatic spondylolistheses of C2 also can occur
- Better known as ___________
- Neurologic injury usually does not occur unless a C2-C3 facet dislocation is present

4 Types:

- A Type I hangman’s fracture is either nondisplaced or has fewer than 3 mm of C2-C3 translation and not angulation of the fragments
- Type II fractures are associated with significant translation of more than 3 mm with angulation
  - These injuries are secondary to initial hyperextension-loading forces, followed by combined flexion/compression forces

- Type III injuries are associated with severe angulation and translation
- Unilateral or bilateral facet dislocations usually accompany them
- The mechanism of injury is a combined flexion/compression force
Subaxial Injuries

- Avulsion Fractures
  - At C7-termed clay shoveler's fractures
  - This injury results from forceful contraction of trapezius and rhomboid muscles or from a sudden severe flexion force transmitted to posterior spinous ligaments
• Compression fractures: loss of anterior body height with preservation of the middle vertebral body column
  
• Evaluate with flexion and extension radiographs, CT scan, and MRI scan
  
• Treatment depends on the degree of anterior compression
  
  • If there is less than 25% anterior compression, allopathic treatment is with a C-collar
  
  • If there is more than 50% anterior compression, patients often have posterior ligamentous failure, resulting in significant instability that requires posterior fusion with or without anterior column reconstruction

• Teardrop fractures result from severe flexion-axial loading forces and are 3-column injuries
  
  • They are characterized by:
    
    • a displaced fracture of the anteroinferior corner of the superior body
    
    • segmental disk disruption
    
    • posterior ligamentous injury
    
    • retropulsion of the proximal body into the neural canal
  
  • Radiographically, retrolisthesis of the posteroinferior portion of the involved body often results in neural compression with deficits ranging from nerve root injuries to complete spinal cord injuries

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**Facet Joint Injuries**

• These subluxations and dislocations occur as a result of disruption of the supraspinous ligaments, interspinous ligaments, ligamentum flavum, and facet capsule

• Neurologic injury varies
  
  • The mechanism of injury corresponds to whether the lesion is unilateral or bilateral.
    
    • Unilateral lesions are the result of flexion and rotation with axial force
    
    • Bilateral lesions are the result of severe flexion with axial loading
  
  • Treatment is controversial because of the risk of further neurologic injury from further disk herniation with the reduction maneuver. The goals of treatment are as follows:
    
    • Prevent further neurologic injury
    
    • Reduce the subluxation/dislocation
    
    • Stabilize the spine in the reduced position

• Unilateral facet dislocation
  
  • AKA: perched facet
  
  • Look first for a disruption of the posterior vertebral body line
Unilateral Facet Dislocation

- AKA: Jumped facets

Risks for Further Injury

- Conditions with a slightly increased risk of re-injury following the initial insult include the following:
  - Asymptomatic osteophytes
  - Healed nondisplaced fractures
  - Stingers/burners
  - Healed disk herniations
  - Healed laminar fractures
  - Asymptomatic foraminal stenosis
• Moderate risk conditions that are associated with a significant chance for recurrence of symptoms and an increased risk for permanent injury include the following:
  • Facet fractures
  • Lateral mass fractures
  • Nondisplaced healed odontoid fractures
  • Nondisplaced healed C1 ring fractures
  • Acute lateral disk herniations
  • Cervical radiculopathy secondary to foraminal spur

• Extreme risk conditions that have the highest risk of recurrence and of permanent damage include the following:
  • Os odontoideum
  • Ruptured transverse ligament of C1-2
  • Occipitocervical dislocation
  • Displaced odontoid fractures
  • Unstable fracture dislocations
  • Cervical cord anomalies
  • Acute central disk herniations

Cervical Spinal Canal Stenosis
• Wolfe (1952)—post body to spinolaminar line (14-23 mm, <13 = stenosis)
• Torg/Pavlov—width of vert body/width for canal space (<.8 = stenosis)
• Herzog—discussed false positives with large vert bodies
• Epstein—the smallest A-P canal diameter had the most severe myelopathy
• Cantu—functional model—stenosis occurs when the protective CSF is obliterated or the cord is deformed

Return to Play (RTP)
• Watkins et al
  1. The extent of neurological injury
  2. The time from injury to treatment
  3. The narrowing of the canal diameter

• 0-6 points - Minimal risk associated with return to play
• 6-10 points - Moderate risk associated with return to play
• 10-15 points - Severe risk associated with return to play